N62661 AR.000396
NAVSTA NEWPORT RI
5090 3a

CRISCUOLO
SHEPARD
ASSOCIATES, PC

936

GEOTECHNICAL ENGINEERING REPORT

FOR

STATIC SLOPE STABILITY EVALUATION

NAVAL EDUCATION AND TRAINING CENTER
CAP McALLISTER POINT LANDFILL
NEWPORT, RHODE ISLAND

PREPARED FOR

TRC ENVIRONMENTAL CORPORATION
5 WATERSIDE CROSSING
WINDSOR, CONNECTICUT

APRIL 1994

Engineers Planners Surveyors

PO Box 866 1764 Foxon Road North Branford, CT 06471 Tel 203/481-8749 Fax 203/488-5729
An Equal Opportunity Employer

TABLE OF CONTENTS

1.0 INTRODUCTION
- 1.1 Purpose of Study
- 1.2 Scope of Services

2.0 GEOMETRY DEVELOPMENT
- 2.1 Cover System
- 2.2 General (Global) Slope Stability

3.0 MATERIAL PROPERTIES ASSUMED

4.0 STATIC SLOPE STABILITY ANALYSIS
- 4.1 Cover System
- 4.2 General (Global) Slope Stability

5.0 SLOPE STABILITY CONSTRUCTION CONSIDERATIONS

6.0 SUMMARY AND CONCLUSIONS

APPENDIX A - COMPUTATIONS WITH ATTACHMENTS
APPENDIX B - CROSS-SECTION I.D. PLAN & CROSS-SECTIONS
APPENDIX C - COMPUTER PRINTOUTS

1.0 INTRODUCTION

1.1 Purpose of Study

The purpose of this study was to review, analyze and develop Geotechnical Engineering recommendations for the static slope stability of the proposed landfill slopes and cover system.

1.2 Scope of Services

Static Slope Stability Analysis

1. Review available site plans and working drawings to determine existing and proposed conditions.
2. Review available soil borings to determine the site geology.
3. Review available groundwater monitoring well data to establish existing/proposed groundwater conditions.
4. Conduct a literature review to establish applicable geotechnical engineering properties for the bulk landfill material.
5. Consult with your staff to integrate specific product type in the analysis of the proposed landfill cap.
6. Conduct a literature review of available angles of friction at interfaces between different cover liner components.

   NOTE: The use of reported values in published literature can only be used with considerable caution. The site specific conditions and the proposed material **must** be used in the tests so as to obtain realistic values of the shear strength parameters. This should be performed before the construction.

7. Conduct a global slope stability analysis on selected critical cross-sections using a computer program called "STABL" developed at Purdue University. This program uses the Modified/Simplified Bishop Method of slices, the Simplified Janbu Method, and Spencer's Method. Specific method used will be determined during analysis.
8. Conduct a cap lining system stability analysis using the classical two-part wedge analysis including dynamic stresses due to installation trafficing.
9. Evaluate the cap lining stability considering exceptionally heavy rains with potential seepage parallel to slope.
10. Prepare an Engineering Report summarizing our work, findings and recommendations.

2.0 GEOMETRY DEVELOPMENT

2.1 Cover System

The cover system geometry used in the analysis was based upon plans submitted to this office on March 30, 1994 by TRC. This cover system consists of the following components in descending order of depth:

Upper West Slope (Area Above Access Road)

- Root reinforcing mat on vegetative slope
- 6" vegetative layer (topsoil)
- 18" cover layer (Soil Type I)
- Non-Woven geotextile
- 12" Drainage Layer (Sand Type D)
- 40 mil VLDPE textured geomembrane
- 6" bedding layer (Soil Type III)
- 12" gas vent layer (Sand Type G)
- 6" cap layer over waste (Soil Type II)
- Existing or relocated waste

Lower West Slope (Area Below Access Road)

- Stone revetment shore protection
- Woven geotextile
- Bedding stone
- Woven geotextile
- 12" drainage sand
- 40 mil VLDPE textured geomembrane
- 6" bedding layer (Soil Type D)
- 12" gas vent layer (Soil Type II)
- 6" cap layer over waste (Soil Type II)
- Existing waste or bedrock

2.2 General (Global) Slope Stability

The global slope stability geometry was developed by first reviewing the proposed grading plan, site geology, bedrock contours and groundwater contours, then applying engineering judgement to select three critical cross-sections taken through the landfill.

These cross-sections labeled A-A, B-B, and C-C were constructed using the Proposed Grading Plans given to this office on March 30, 1994, Bedrock Contour Map dated 2/94 (Figure 3-9) and Groundwater Contour Map dated 2/94 (Figure 3-13). (See Appendix B for Section I.D. Plan and Sections.)

3.0 MATERIALS PROPERTIES

The procedure used to determine the required material properties was by the Correlation Method. This method, in general, consists of specifying a certain type of material to obtain a required general property. General material types are correlated to properties.

Soil properties for proposed materials were correlated using specified group symbols as indicated in specifications and NAVFAC DM-7, March 1971 and NAVFAC DM-7 May 1982 table and graph for typical soil index properties.

Landfill waste properties were taken from Geotechnical Special Publication No. 31, "Stability and Performance of Slopes and Embankments - II" by Raymond B. Seed and Ross W. Boulanger, and from a 1976 University of Connecticut master thesis by Geoffrey Guy Jillson entitled, "Measurement of the Engineering Properties of Municipal Incinerator Residues and Consideration of Leachate Characteristics".

The geotextile interface friction angle was obtained from the publication "Designing With Geosynthetics", Second Edition by Robert M. Koerner.

The references on textured VLDPE geomembrane frictional properties were limited. Numerous data was available on HDPE textured geomembrane than on textured VLDPE. The interface friction angle of textured VLDPE was estimated using the HDPE values as a guide with only one actual shear test reference on textured VLDPE.

All analyses of the cover system and global slope stability was based upon the above correlated material properties. No direct laboratory material properties were performed.

It is very important to note that it has been shown through research that the interfacial friction between soils and geotextiles and geomembrane has a wide range of values. It is **absolutely** necessary to perform shear tests on the proposed materials to be used in construction before construction commences to verify design assumptions and make any design modification, if required.

4.0 STATIC SLOPE STABILITY ANALYSIS

4.1 Cover System

A Static Slope Stability Analysis was performed on the proposed cover section using the correlated material properties. Two (2) different models were used in the analysis - The Infinite Slope Theory and the Sliding Block Method with the Infinite Slope Method being the more conservative method as it does not consider passive block failure.

Groundwater flowing parallel to slope was also included in the analysis with a maximum groundwater depth of ±2", which was given by TRC from their computer model with 4" used in analysis. The result of the analysis is as follows:

Factor of Safety of the Static Slope Stability (Cover System)

	Infinite Slope Model	Sliding Block Model
Dry Condition	1.34	1.47
With Groundwater	1.26	1.38

4.2 General (Global) Slope Stability

A Static (Global) Slope Stability Analysis was performed on three (3) selected cross-sections (See Appendix B) using a computer program called "STABL" developed at Purdue University. The program was developed to incorporate a limit equilibrium method that uses the simplified Janbu Method, the simplified Bishop Method or Spencer's Method. The Janbu Effective Stress Method was used in the analysis, as this method

gave the lowest factor of safety. The Janbu Method (1954, 1973) satisfies both force and moment equilibrium and is applicable to failure surfaces of any shape.

An automatic searching routine was used in the "STABL" program in which hundreds of potential failure surfaces were evaluated by specifying surface initiation, termination ranges and minimum allowable surface conditions to find the lowest ten (10) potential failure surfaces. This output was analyzed to determine the critical failure surface. The results of the static global slope stability are as follows:

Cross-Section I.D.	Lowest Rotational Factor of Safety
A-A	2.30
B-B	2.10
C-C	1.98

4.3 Existing Stability Charts

A review was made of available stability charts to use as a check of the results of the "STABLE" computer solution for Cross-Section C-C. Bishop/Morgenstern, Spencer's, Cousins Charts were used for a rotational type failure and the Huang Chart was used for triangular type failure. The results of the charts are as follows:

Chart Name	Static Factor of Static
Bishop/Morgenstern	1.95
Spencer's	1.90
Cousins	1.88
Huang	2.08

These values check very well with the computer calculated 1.98 from "STABL".

5.0 SLOPE STABILITY "CONSTRUCTION CONSIDERATIONS"

Three analyses were performed to review the implication of slope stability during the construction stage. The first analysis looked at a typical tract type equipment placing the drainage sand on the geomembrane. The results of this analysis indicated a potential slope failure if the operator was allowed to stop suddenly (Refer to computations). The analysis reflects that the size of equipment, and the operation of the equipment, is very important in the stability of the cover system and should be carefully considered in the specification and during construction.

The second analysis was performed to review the implication of the contractor installing the drainage sand and a significant rainfall event occurring. The long term groundwater model by TRC assumes the total cover section is in place and runoff will occur. During construction, if the impervious materials are not in place, 100% of a rainfall event could infiltrate the drainage layer and result in temporary instability of the slope. Our analysis indicates less than 4" of rainfall could cause a potential slope failure (Refer to computations). This condition should be addressed in the construction installation sequence or temporary covering system.

The third analysis was performed to review the implication of the rock revetment being maintained by the use of equipment on the gravel access ring road. Our analysis indicates that the size of this equipment should be limited to less than 20 tons. The actual machine size can be adjusted once actual interface friction angles are determined.

As a final comment, during construction and after construction is completed, the potential exists for occasional sloughing. This sloughing is due to the heterogeneity in the cover material and variations in construction installation and will occur during periods of heavy rain where temporary saturation of local areas will cause loss of shear strength. This sloughing occurrance will become reduced once a good vegetative layer has been established.

6.0 CONCLUSION AND SUMMARY

The evaluation of the effectiveness of the landfill design can only be based upon comparing the calculated values with the acceptable minimum factors of safety for static conditions. Currently there is no standardized values.

In establishing these minimum values, the consequences of slope failure would have to be considered. At a minimum, the following should be considered: environmental impacts, cost of repair, and cost to increasing factors of safety.

The calculated value of factor of safety for static conditions, to use for comparison purposes, is as follows:

	Static Factor of Safety
Cover System	1.26 to 1.38
Global Landfill	1.98

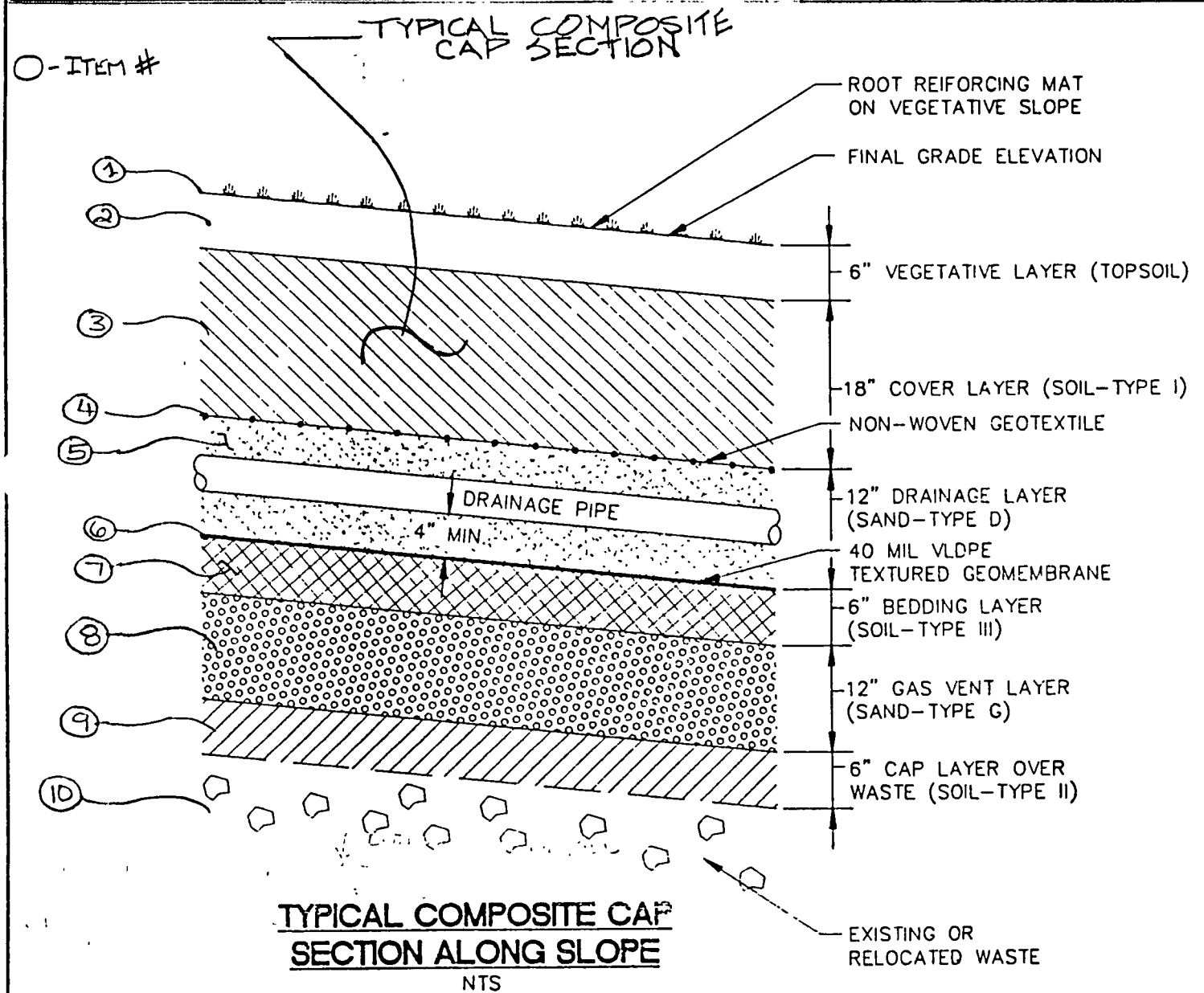
APPENDIX A

COMPUTATIONS WITH ATTACHMENTS

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 1 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
SCALE

STATIC STABILITY ANALYSIS FOR LANDFILL COVER SYSTEM



TYPICAL COMPOSITE CAP SECTION ALONG SLOPE
NTS

SECTION TAKEN FROM PLANS TITLED "CAP McALLISTER POINT LAND FILL - LANDFILL CAP DETAILS" SHEET C-10 NO DATE NOTED, RECIEVED THIS OFFICE 3-30-94.

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 2 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
SCALE

MATERIAL PROPERTIES ASSUMED FOR DESIGN:

NOTE: ALL MATERIAL PROPERTIES ARE ASSUMED AND BASED ON CORRELLATION AND ENGINEERING JUDGEMENT

ITEM NO. 1 - ROOT REINFORCING MAT

NOTE: THIS REINFORCING MAT IS FOR SURFACE EROSION. NOT INCLUDED IN THIS ANALYSIS. TO BE DESIGNED BY TRC.

ITEM NO. 2 - 6" VEGETATION LAYER (TOPSOIL)

NOTE: THE FOLLOW MATERIAL PRODUCT SPECIFICATION TAKEN FROM FAX OF MATERIAL SPECIFICATION. FAX TO THIS OFFICE ON 3-29-94 BY TRC. "RON NAULT".

2.1.1 Vegetative Layer (Topsoil) Material

a. SHS-RIDOT M.20.01 Loam Materials

b. Well graded with a maximum stone size of 2 inches and a minimum 35 percent by weight passing the No. 200 sieve.

c. Capable of supporting root and plant growth.

TOPSOIL TYP. > 5 % ORGANICS
LOAMY SAND COMPACTION REQUIREMENT 90% ASTM D 1557

ASSUMED PROPERTIES: (SEE SHEET 1 & 2 APPENDIX "A", TABLE 2)
USE SM-SC (SAND-SILT CLAY MIX WITH SLIGHTLY PLASTIC FINES
USE IN DESIGN: FRICTION ANGLE 33°
γ_{moist} = 130 #/FT³
Cohesion = 0

ITEM NO. 3 - 18" COVER LAYER (SOIL-TYPE 1)

2.1.2 Cover Layer (Soil-Type I) Material

a. Cover layer material shall be soil free of trash, ice, snow, tree stumps, roots and other deleterious materials. Cover layer material shall be well graded with a maximum stone size of 4 inches and shall not contain less than 20 percent nor more than 35 percent by weight of silt and clay. It shall be of such a nature and character that it can be compacted to the specified densities and classified SM, SC, SP-SC, SP-SM, SW-SC or SW-SM as determined by

SECTION 02220 PAGE 5

ASSUMED MAT.: USED IN DESIGN SC FOR DESIGN (CLAYEY SANDS, POORLY GRADED SAND-CLAY MIX)

ASSUMED COMPACTION REQUIREMENT 90% ASTM D1557

FORM 17 © 1991 Dietzgen Corporation Graphic Products Inc. Groton Mass 01471 To Order PHONE TOLL FREE 1-800-225-6130

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 3 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
SCALE

PROPERTIES USED IN DESIGN: friction Angle 31°
γ_{moist} = 135 #/Ft³
Cohesion = 0

ITEM NO. 4 - NON-WOVEN GEOTEXTILE

NOTE:
IMPORTANT PROPERTY FOR STABILITY DESIGN IS INTERFACIAL FRICTION VALUE.

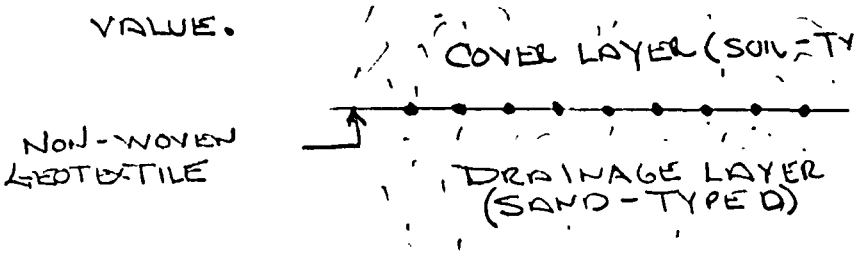


TABLE 2 6 SOIL-TO FABRIC FRICTION ANGLES AND EFFICIENCIES (IN PARENTHESES) IN COHESIONLESS SOIL

Geotextile type	Manufacturer's designation	Concrete sand ϕ = 30 deg	Rounded sand ϕ = 28 deg	Silty sand ϕ = 26 deg
Woven, monofilament	Polyfilter X	26 deg (84%)	—	—
Woven, slit film	500X	24 deg (77%)	24 deg (84%)	23 deg (87%)
Nonwoven, melt bonded	3401	26 deg (84%)	—	—
* Nonwoven, needle punched	CZ600	30 deg (100%)	26 deg (92%)	25 deg (96%)

Source After Martin et al [13]

TABLE NO. 3 (ATTACHMENT "1")
NONWOVEN NEEDLEPUNCHED GEOTEXTILE — COMPACTED SAND
ϕ = 25° - 35°
NONWOVEN NEEDLEPUNCHED GEOTEXTILE — COMPACTED CLAY
ϕ = 20° - 35°

ASSUMED IN DESIGN
NON-WOVEN GEOTEXTILE / COVER LAYER (SOIL-TYPE 1)
INTERFACIAL FRICTION ϕ = 25°
NON-WOVEN GEOTEXTILE / DRAINAGE SAND (SAND-TYPE D)
INTERFACIAL FRICTION ϕ = 26°

NOTE: IT HAS BEEN SHOWN THROUGH RESEARCH THAT THE INTERFACIAL FRICTION BETWEEN SOILS AND GEOTEXTILES HAS A WIDE RANGE OF VARIATIONS. IT IS "ABSOLUTLY" NECESSARY TO PERFORM SHEAR TEST ON PROPOSED MATERIAL TO BE USED IN CONSTRUCTION BEFORE CONSTRUCTION TO VARIFY DESIGN ASSUMPTIONS AND MODIFY DESIGN IF REQUIRED.

ITEM NO 5 - 12" DRAINAGE LAYER (SAND-TYPE D)

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel. 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 4 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
* REV. 4-6-94 TRC COMMENTS
SCALE

2.1.3 Drainage Layer (Sand-Type D) Material

Drainage layer material shall be a uniformly graded sand free of clay, organics or other deleterious material meeting the following requirements:

a. Provide a minimum compacted permeability of 1×10^{-2} cm/sec.

b. Meet the gradation listed below.

Sieve Designation	Percent by Weight Passing
1/2 inch	100
3/8 inch	85-100
No. 4	60-100
No. 10	35-85
No. 40	10-55
No. 100	0-10

c. Classified as SP as determined by ASTM D 2487.

USE SP IN DESIGN - POORLY GRADED CLEAN SANDS, SAND-GRAVEL MIX

ASSUMED IN DESIGN — FRICTION ANGLE = *32°
γ_{moist} = 126 #/FT³
Cohesion = 0

TABLE NO 3. ATTACHMENT "1"
TEXTURED GEOMEMBRANE
TO COMPACTED CLAY >10°-32°
TO COMPACTED SAND 20°-35°

ITEM NO. 6 - 40 MIL VLDPE TEXTURED GEOMEMBRANE
DRAINAGE LAYER

TABLE NO. 4. ATTACHMENT "1"
TEXTURED GEOMEMBRANE
TO DRAINAGE SAND 39°
TO COMPACTED CLAY 38°

40 MIL VLDPE TEXTURED GEOMEMBRANE

BEDDING LAYER

TABLE NO. 5 40°-45°

NOTE: IMPORTANT PROPERTY FOR STABILITY DESIGN IS INTERFACIAL FRICTION.

NOT MUCH INFORMATION AVAILABLE ON VLDPE (TEXTURE)
USED COMBINATION OF HDPE (TEXTURED) AND VLDPE FOR DESIGN.

TABLE 2. Summary of Measured Interface Friction Angles

Membrane number (1)	Membrane type (2)	Drainage sand (ϕ = 30°) (3)	Efficiency[a] (4)	Silt liner (ϕ = 28°) (5)	Efficiency[a] (6)
1	Smooth	NT[b]	—	12	0.43
1	Roughened	20	0.67	29	1.0
2	Smooth	20	0.67	12	0.43
2	Roughened	22	0.73	31	1.0
3	Smooth	19	0.63	10	0.36
3	Roughened	20	0.67	32	1.0

[a]Interface was not tested
[b]Defined as the ratio of interface friction angle to soil friction angle

DR. CLARENCE WELTI, P.E., P.C.
GEOTECHNICAL ENGINEERING
227 Williams Street • P.O. Box 397
Glastonbury CT 06033
(203) 633-4623 / FAX (203) 657 2514

June 9, 1992

Fuss & O'Neill Inc.
146 Hartford Road
Manchester, CT 06040

Att: Scott Atkins

Re: Shelton Ash Landfill; CRRA
Assessment of Friction Factor on Liner Element

Dear Mr. Atkins:

Herewith are friction data pertaining to the following:

1.	Screened Ash - loose	28 degrees
2a.	Smooth HDPE on Sand (see attached grain size gradation)	37.5 degrees
2b	Rough HDPE on Sand	39 degrees
3a.	Smooth HDPE on Geo-Grid	15 degrees
3b.	Rough HDPE on Geo-Grid	18 degrees
4a.	Smooth HDPE Composite Textile - Geo-Grid Textile	15-26 degrees
4b.	Rough HDPE on Composite	32 degrees

The stone on the HDPE would have a friction angle of at least 32 degrees

It is presumed that the maximum slope of the liner will be 3:1 or about 19 degrees. This would allow a factor of safety against sliding of at least 1.87

Form 301 1 Sample Sheets 305 1 Pad Mail Inc Groton Mass 01471 To Order PHONE TOLL FREE 1 800 225 6350

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers ▪ Planners ▪ Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 5 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
* REV: 4-6-94 TRC COMMENTS
SCALE

INTERFACIAL FRICTION RANGE 20° → 45°

NOTE: IT HAS BEEN SHOWN THROUGH RESEARCH THAT THE INTERFACIAL FRICTION BETWEEN SOILS AND GEOTEXTILES HAS A WIDE RANGE OF VARIATIONS. IT IS "ABSOLUTLY" NECESSARY TO PERFORM SHEAR TEST ON PROPOSED MATERIAL TO BE USED IN CONSTRUCTION BEFORE CONSTRUCTION TO VARIFY DESIGN ASSUMPTIONS AND MODIFY DESIGN IF REQUIRED.

ASSUMED IN DESIGN

		Δ EFFICIENCY	
VLDPE (TEXTURED) / DRAINAGE LAYER	32° × 0.75 =	24°	*
VLDPE (TEXTURED) / BEDDING LAYER	32° × 0.85 =	27°	*

Δ = DEFINED AS THE RATIO OF INTERFACE FRICTION ANGLE TO SOIL FRICTION ANGLE

* = VERY IMPORTANT ASSUMPTION IN DESIGN

* TO OBTAIN MORE INFORMATION FROM MANUFACTURES: (SEE TABLE NOS 6 UNDER)

ITEM NO. 7 – 6" BEDDING LAYER (SOIL-TYPE III)

2.1.6 Bedding Layer (Soil-Type III) Material

a. Bedding layer material shall be soil free of trash, ice, snow, tree stumps, roots and other organic and deleterious materials. Bedding layer material shall be well graded, meeting the following gradation:

Sieve Designation	Percent by Weight Passing
1 inch	100
No. 4	80-100
No. 200	20-35

b. It shall be of such a nature and character that it can be compacted to the specified densities and classified SM or ML as determined by ASTM D 2487.

c. Provide a minimum compacted permeability of 1×10^{-5} cm/sec.

USE "ML" IN DESIGN – (INORGANIC SILTS AND CLAYEY SILTS)

USE IN DESIGN: friction ANGLE = 32°

γ_{moist} = 120 #/ft³

Cohesion = 0

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB MC ALLISTER POINT LANDFILL
SHEET NO 6 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
SCALE

ITEM NO. 8 – 12" GAS VENT LAYER (SAND – TYPE G)

2.1.4 Gas Vent Layer (Sand-Type G) Material

The gas vent layer material shall consist of well graded sand free of clay, organics or other deleterious material meeting the following requirements:

a. Provide a minimum compacted permeability of 1×10^{-3} cm/sec.

b. Conform to the gradation requirements listed for the drainage layer material of this section plus or minus 5 percent with all material passing the 1/2 inch sieve.

ASSUME A ASTM CLASSIFICATION SP
– POORLY GRADED CLEAN SANDS, SAND-GRAVEL MIX.
ASSUMED COMPACTION REQUIREMENT 90% ASTM D1557
ASSUMED IN DESIGN – FRICTION ANGLE = 37°
γ_{moist} = 126 #/FT³
Cohesion = 0

ITEM NO. 9 – 6" CAP LAYER OVER WASTE (SOIL – TYPE II)

2.1.5 Cap Layer (Soil-Type II) Material

a. Cap layer material shall be soil free of trash, ice, snow, tree stumps, roots and other organic and deleterious materials. Cap layer material shall be well graded with a maximum stone size of 4 inches and a maximum 35 percent by weight passing the No. 200 sieve. It shall be of such a nature and character that it can be compacted to the specified densities and classified SM, SC, SP-SC, SP-SM, SW-SC or SW-SM as determined by ASTM D 2487.

USE "SC" VALUES IN DESIGN (CLAYEY SANDS, POORLY GRADED SAND-CLAY MIX)

ASSUMED COMPACTION REQUIREMENT 90% ASTM D1557
PROPERTIES USED IN DESIGN: friction ANGLE 31°
γ_{moist} = 135 #/FT³
Cohesion = 0

ITEM NO. 10 – EXISTING OR RELOCATED WASTE

Copyright © 2011 Micro Inc. Groton Mass 01471 To Order PHONE TOLL FREE 1 800 225 6380

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 7 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
SCALE

WASTE TYPE:

Site History and Background

REF: REPORT BY: TRC ENVIRONMENTAL
ENTITLED: REMEDIAL INVESTIGATION
SITE 01 - McALLISTER POINT LANDFILL
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

- Used as landfill (1955 to mid-1970s)
- Approximately 11.5 acres
- Reported disposal of domestic refuse and operational wastes
- On-site waste incineration prior to disposal (1965 to early 1970s)
- Filling of Narragansett Bay (historical aerial photos, 1965 to 1975)
- Site is inactive (mid-1970s to present)

NOTE: BORING INDICATE BOTH
BULK WASTE & INCINERATOR WASTE

DENSITY

BULK WASTE

WEIGHT OF REFUSE UNDER CERTAIN CONDITIONS

Condition of Refuse	lb/cf	Weight (lb/yd³)
Loose refuse at curb		125 to 240
Normal compacted refuse in a sanitary landfill	27	750 to 850 31
Well-compacted refuse in a sanitary landfill	37	1,000 to 1 250 46
In compactor truck		300 to 600
Shredded refuse, uncompacted		600
Shredded refuse, compacted		1,600
Compacted and baled		1,600 to 3,200
Apartment house compactor		700
In incinerator pit		500 to 550

$\gamma_0 = 27 - 46$ #/ft³

REF: ENVIROMENTAL ENGINEERING AND SANITARYTION
SALVATO, WILEY-INTERSCIENCE, 1972

Engineering Properties of Incinerator Residues
Tabulated From Chapter III

B 1 Batch Feed Municipal Incinerator Residue, W. Hartford

Proctor Compaction	γ_d = 79.5 pcf @WC=20 0% γ_r = 95.4 pcf γ_s = 106.2 pcf
Specific Gravity	2.42
Void Ratio	0.75
Porosity, n	0 43
Permeability, K	$4\ 0 \times 10^{-5}$
Friction Angle, Triaxial	ϕ = 40 5° average
Consolidation Data	Moderately Compressible approx 80% occurs rapidly, remainder long with $C_\alpha = 4.3 \times 10$
Grain Size Distribution L'in	42% gravel size 50% sand size 8% silt size or smaller Well graded

REF: SEE ATTACHMENT "1"

WASTE UNIT WEIGHT

Waste unit weight data reported by Richardson and Reynolds (1991) show that MSW can be much heavier than previously thought While unit weight will have little influence on the drained stability of primarily frictional materials, it can affect the results of undrained and partially drained analyses The stability calculations for the subject landfill were redone with a waste density of 95 pcf The factor of safety decreased from 1 5 to 1 4 for partially drained conditions and from 1 6 to 1 5 for long term (drained) conditions Based on a recent survey of the landfill, the owners calculated a waste unit weight of approximately 75 pcf

γ_{moist} (BULK WASTE) = 27 - 75 #/ft³

γ_{moist} (INCINERATOR WASTE) = ±100 - 120 #/ft³ ← SEE ATTACHMENT "1"

RANGE 27 - 120 #/ft³

ASSUMED DENSITY USED IN DESIGN → 100 #/ft³

FRICTION ANGLE

INCINERATOR WASTE:

FROM REF: IN ATTACHMENT "1" PG 4. $\phi = 39° \rightarrow 48°$

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel. 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 8 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
SCALE

BULK WASTE: FROM REF. SEE ATTACHMENT "1" PG 5
Cohesion 200 #/FT²
$\phi = 23°$

APPROXIMATION METHOD (VIEWING EXISTING TOPO. MAP BY TRC)
EXISTING SLOPE (ANGLE OF REPOSE) IS A INDICATOR OF FRICTION ANGLE

TAKE AVERAGE OF 7 CROSS SECTION ALONG SHORE LINE

EXISTING SLOPE ANGLE @ SHORE LINE

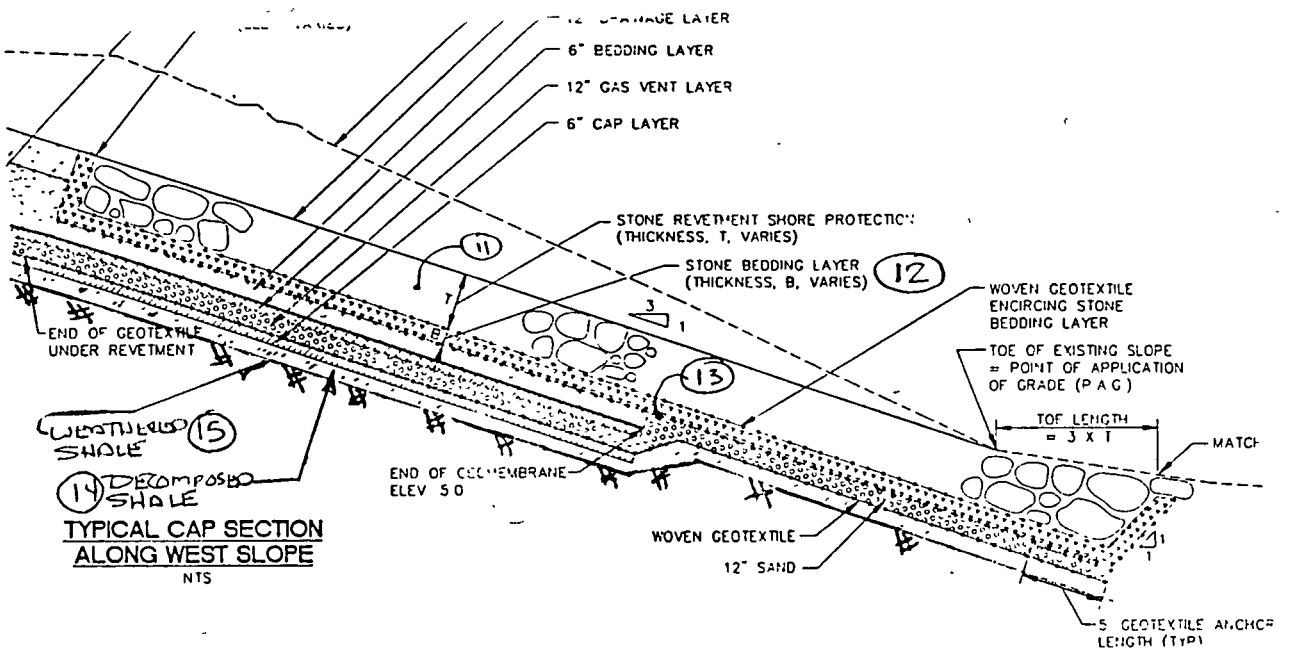
1. 31.6°
2. 32°
3. 36°
4. 28.5°
5. 21.0°
6. 28.°
7. 20°

AVG 28° AVG

USED IN DESIGN
$\phi = 23°$
$C = 200$ #/FT²

ROCK REVETMENT MATERIAL PROPERTIES

O = ITEM NUMBER



TYPICAL CAP SECTION ALONG WEST SLOPE
NTS

Gordon, Mass. 01471 To Order PHONE TOLL FREE 1 800 225 6380

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 9 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
SCALE

ITEM NO. 11. — STONE REVETMENT SHORE PROTECTION

$\gamma_{moist} = 110$ #/ft³

$\phi = 45°$ TYP. LARGE BLASTED ANGULAR ROCK (SEE "ATTACHMENT 1")

2.1.10 Riprap

SHS-RIDOT M.10.03.2 Stone for Riprap. Riprap stone shall consist of hard, durable rock which will not disintegrate by exposure to water or weather and conform to Class Size A, B or C gradations and full requirements of SHS-RIDOT M.10.03.2.

ITEM NO. 12 — STONE BEDDING LAYER

2.1.9: Bedding for Riprap

SHS-RIDOT M.10.03.1 Bedding Stone. Bedding stone shall be obtained from rock of uniform quality and shall consist of clean, angular fragment of quarried rock, free from soft or disintegrated pieces or other objectionable matter. The stone shall meet the following gradation requirements:

Sieve Designation	Percent by Weight Passing
3-1/2 inch	100
3 inch	90-100
2 inch	60-80
1 inch	0-20
3/4 inch	0-5

$\gamma_{moist} = 100$ #/ft³

$\phi = 43°$ TYP. CRUSHED ANGULAR ROCK (SEE ATTACHMENT "1")

ITEM NO. 13 — WOVEN GEOTEXTILE

SEE REF: ITEM 4

INTERFACE FRICTION		ϕ
STONE REVETMENT /	GEOTEXTILE	24°
STONE BEDDING /	GEOTEXTILE	24°
DRAINAGE SAND /	" "	24°
CAP LAYER /	" "	23°
GAS VENT SAND /	" "	24°

ITEM NO. 14 — ASSUMED DECOMPOSED SHALE @ INTERPHASE OF OF WASTE/ROCK

ASSUME A LAYER OF SHALE DECOMPOSES TO A CLAY OF LOW PLASTICITY: SEE LABORATORY TEST RESULTS BY THIS OFFICE

ASSUME CL MATERIAL SEE TABLE #2 ATTACHMENT "1"

$\phi = 28°$

$\gamma_{moist} = 120$ #/ft³

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 10 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
* REV. 4-6-94 TRC COMMENTS
SCALE

ITEM NO 14 — WEATHERED ROCK (SHALE)

SEE ATTACHMENT 1" PG 6

USED IN DESIGN:

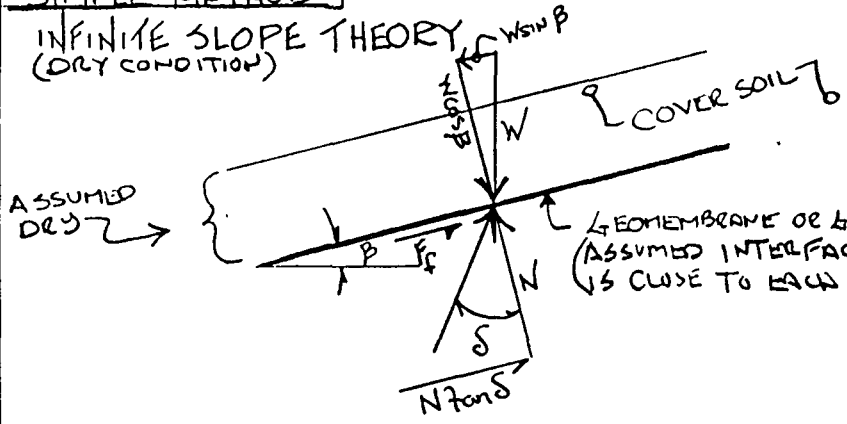
ϕ = USE 35°

γ_{moist} = 168 #/ft³

STATIC STABILITY ANALYSIS (MODEL #1)

SIMPLE METHOD

INFINITE SLOPE THEORY
(DRY CONDITION)



ASSUMPTION: ① "DRY CONDITION" NO WATER ENTERING COVER SOIL

② LOWEST FRICTION ANGLE OF COVER SYSTEM IS AT THE GEOMEMBRANE/SOIL INTERFACE * OR GEOTEXTILE/SOIL INTERFACE DEPENDING UPON ACTUAL MATERIALS USED IN CONSTRUCTION, AND RESULTS OF SHEAR TEST RESULTS.

③ SLOPE ANGLE AS INDICATED OF TRC DRAWING 3:1 ≈ 18.4°

$$FS = \frac{\text{RESISTING FORCES}}{\text{DRIVING FORCES}} = \frac{F_f}{W\sin\beta} = \frac{N\tan\delta}{W\sin\beta} = \frac{W\cos\beta\tan\delta}{W\sin\beta}$$

CONTROLLED BY GEOMEMBRANE

$$FS = \frac{\tan\delta}{\tan\beta} = \frac{\tan 24^\circ *}{\tan 18.4^\circ} = \frac{0.445}{0.3327} = \underline{\underline{1.34}} *$$

EQUATION ABOVE APPLIES ONLY WHEN THE COVER SOIL IS DRY OR SUBJECTED TO A HYDROSTATIC WATER PRESSURE DISTRIBUTION.

INFINITE SLOPE THEORY

(FOR THE CASE OF UNIFORM, "FULL DEPTH" SEEPAGE IN A COVER SOIL LAYER, WHERE THE HEAD LOSS GRADIENT IS NUMERICALLY EQUAL TO THE TANGENT OF THE SLOPE ANGLE

$$FS = \frac{\gamma_s - \gamma_w}{\gamma_s}\,\frac{\tan\delta}{\tan\beta} = \frac{\gamma_b}{\gamma_s}\,\frac{\tan\delta}{\tan\beta}$$

γ_s = SATURATED UNIT WEIGHT
γ_b = BOUYANT UNIT WEIGHT
γ_w = UNIT WEIGHT OF WATER

ASSUMPTION: γ_w = 62.4 #/ft³
TABLE NO 1 APPENDIX "A": γ_b = 55.6 #/ft³
γ_s = 118 #/ft³

USE LOWEST SAT DENSITY TO GIVE LOWEST F.S.

$$FS = \frac{55.6}{118}\,\frac{\tan 24^\circ}{\tan 18.4^\circ} = \underline{\underline{0.63}}$$

COVER WILL FAIL WHEN COVER SECTION IS < THAN FULLY SATURATED SEE SEE 14 FOR MORE DETAILS

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 11 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
* REV. 4-6-94 TRC COMMENTS
SCALE

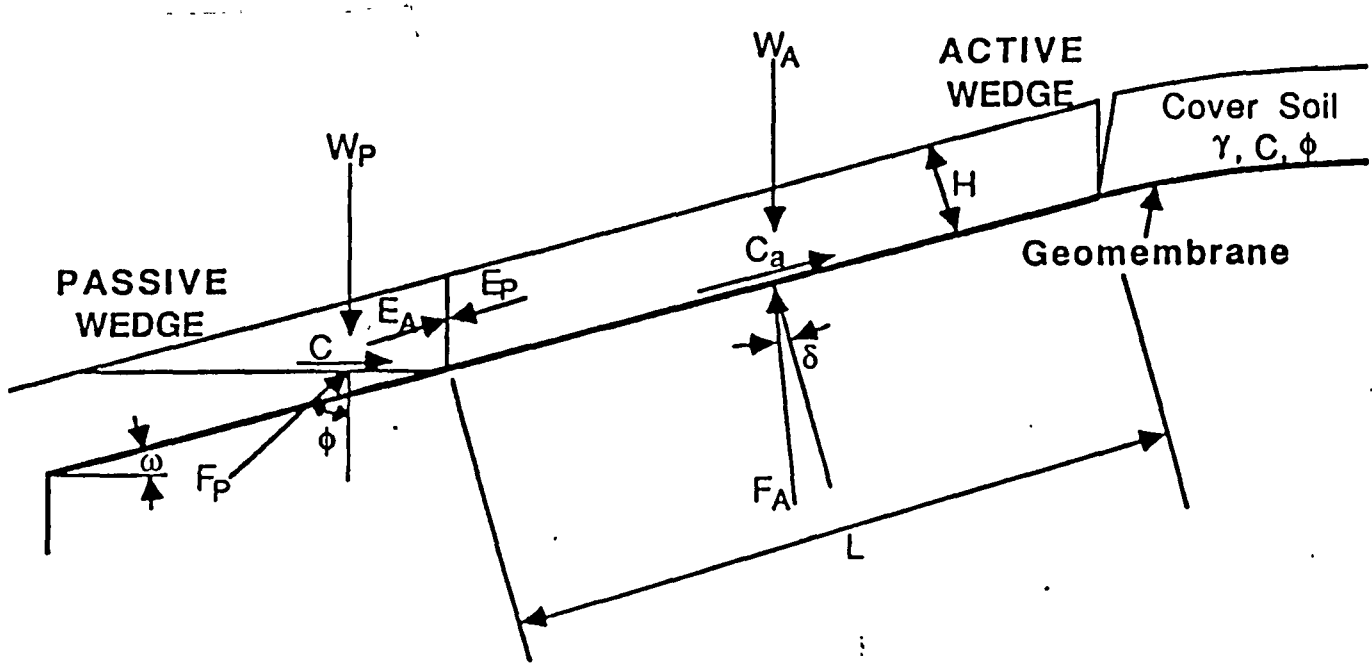
THE ABOVE VALUE OF 0.63 FOR F.S. INDICATES THE IMPORTANCE OF GOOD DRAINAGE SYSTEM ABOVE THE GEOMEMBRANE. IT HAS BEEN INDICATED BY TRC-RUN NAULT THAT A ANALYSIS WAS PERFORMED ON THE COVER SYSTEM AND THE MAXIMUM DEPTH OF WATER CALCULATED FOR THE BAY SIDE SLOPE IS ON THE ORDER OF 2"±. THIS WOULD INDICATE THE FACTOR OF SAFTY CALCULATED IS CLOSE TO 1.34

** SLOPE COVER SYSTEM MUST BE DESIGNED WITH A ADEQUATE DRAINAGE SYSTEM TO MINIMIZE WATER FLOWING PARALLEL TO SLOPE

STATIC STABILITY ANALYSIS (MODEL *2)

METHOD BY: ROBERT M. KOERNER AND BAO-LIN HWU
GEOSYNTHETIC RESEARCH INSTITUTE
DREXEL UNIVERSITY
PHILADELPHIA, PENNSYLVANIA 19104

PAPE TITLE: STABILTY AND TENSION CONSIDERATIONS REGARDING COVER SOILS ON GEOMEMBRANE LINED SLOPES.



Cross Section of Cover Soil on a Geomembrane Illustrating the Various Forces Involved on the Active and Passive Wedges

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 12 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
* REVISED 4-6-94 COMMENTS TRC
SCALE

THE RESULTING FACTOR-OF-SAFETY IS AS FOLLOWS:

* CHECK BOTH INTERFACES DUE TO CLOSENESS IN ϕ VALUES.

$$FS = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$a = 0.5\gamma L H \sin^2 2\omega$$

$$b = -[\gamma L H \cos^2\omega \tan\delta \sin(2\omega) + C_a L \cos\omega \sin(2\omega) + \gamma L H \sin^2\omega \tan\phi \sin(2\omega) + 2cH\cos\omega + \gamma H^2 \tan\phi]$$

$$c = (\gamma L H \cos\omega \tan\delta + C_a L)(\tan\phi \sin\omega \sin(2\omega)]$$

UPPER SLOPE ANALYSIS

ASSUMPTIONS: 3:1 SLOPE, 18.4° AT GEOTEXTILE/SOIL INTERFACE

(See ATTACHMENT "2" FOR ASSUMED FAILURE PLANE)

- L = 70'
- H = 2' @ GEOTEXTILE/SOIL INTERFACE
- γ = 135 #/FT³ AVG.
- C = 0
- C_a = 0
- ϕ = 31°
- δ = 25° INTERFACE GEOTEXTILE/SOIL INTERFACE

$$a = 0.5(135)(70)(2)\sin^2(36.8°)$$
$$= 3390 \text{ lb/ft}$$

$$b = -[(135)(70)(2)\cos^2(18.4°)\tan(25°)\sin(36.8°) + 0 + (135)(70)(2)\sin^2(18.4°)\tan(31°)\sin(36.8°) + 0 + 135(2^2)\tan 31°]$$
$$= 14753 + 0 + 677 + 0 + 320$$
$$= -5750 \text{ lb/ft}$$

$$c = [(135)(70)(2)\cos(18.4°)\tan(25°) + 0][\tan(31°)\sin(18.4°)\sin(36.8°)]$$
$$= 18362 \times .1136$$
$$= 950 \text{ lb/ft}$$

$$FS = \frac{5750 + \sqrt{(-5750)^2 - 4(3390)(950)}}{2 \times 3390} = \frac{10242}{6780} = \underline{\underline{1.51}}$$ @ INTERFACE OF SOIL/GEOTEXTILE

* INFINITE SLOPE THEORY @ GEOTEXTILE/SOIL INTERFACE

$$* \; FS = \frac{\tan 25}{\tan 18.4} = \frac{0.4663}{0.3327} = 1.4$$

1.5 > 1.4 DUE TO PASSIVE FORCE ANALYSIS OK DOES NOT CONSIDER H_2O

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel. 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 12A OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
SCALE

UPPER SLOPE ANALYSIS AT GEOMEMBRANE/SOIL INTERFACE

ASSUMPTIONS: 3:1 SLOPE 18.4°
$L = 70'$
$H = 3'$ @ GEOMEMBRANE/SOIL INTERFACE
$\gamma = 135\ ^{\#}/FT^3$ AVE
$c = 0$
$C_a = 0$
$\phi = 31°$
$\delta = 24°$ INTERFACE GEOMEMBRANE/SOIL INTERFACE

$$a = 0.5(135)(70)(3)\sin^2(36.8°)$$
$$= 5086\ lb/FT$$
$$b = -\left[(135)(70)(3)\cos^2(18.4°)\tan(24°)\sin(36.8°) + 0 + (135)(70)(3)\sin^2(18.4°)\tan(31°)\sin(36.8°) + 0 + 135(3^2)\tan 31\right]$$
$$= 6807 + 0 + 1017 + 0 + 730$$
$$= -8554\ lb/FT$$
$$c = \left[(135)(70)(3)\cos(18.4°)\tan(24°) + 0\right]\left[\tan 31° \sin(18.4°)\sin(36.8°)\right]$$
$$= 11977 \times .1136$$
$$= 1360\ lb/FT$$

$$F.S. = \frac{+8554 + \sqrt{-8554^2 - 4(5086)(1360)}}{2 \times 5086} = \frac{15299}{10172} = 1.50$$

FACTOR OF SAFETY @ GEOMEMBRANE/SOIL INTERFACE ≈ FACTOR OF SAFETY @ GEOTEXTILE/SOIL INTERFACE ±1.5"

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO. 13 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
REV. = 4-6-94 COMMENTS TEC
SCALE

TOTAL SLOPE ANALYSIS @ GEOMEMBRANE/SOIL INTERFACE

ASSUMPTIONS: 3:1 SLOPE 18.4°
L = 150'
(SEE ATTACHMENT "2") H = VARIES USE 3' TO 5.8' USE H THAT GIVE LOWES F.S.
FOR ASSUMED FAILURE PLANE) $\gamma = 131\ \#/FT^3$
$C = 0$
$C_a = 0$
$\phi = 43°$ FRICTION ANGLE THROUGH STONE BEDDING AND STONE REVETMENT
$\delta = 24°$ GEOMEMBRANE/SOIL INTERFACE

$a = 0.5(131)(150)(3)\sin^2(36.8)$
$a = 10576$ lb/ft
$b = -[(131)(150)(3)\cos^2(18.4°)\tan(24°)\sin(36.8°)$
$+ 0 + (131)(150)(3)\sin^2(18.4°)\tan(43°)\sin(36.8°) + 0$
$+ 131(3^2)\tan 43°$
$= 14155 + 0 + 3280 + 1091 = 18534$ lb/ft
$c = [(131)(150)(3)\cos(18.4)\tan(24°) + 0][\tan(43°)\sin(18.4°)\sin(36.9°)]$
$= 24904 \times .176$
$= 4383$ lb/ft

$$FS = \frac{18534 + \sqrt{(-18534)^2 - 4(10576 \times 4383)}}{2 \times 10576} = \frac{31107}{21,152} = \underline{1.47} \ *$$

FS @ H = 6 = 1.59 USE: H = 3.0 FOR DESIGN

NOTE: THE ABOVE ANALYSIS DOES NOT INCLUDE, CONSTRUCTION SEISMIC, AND HYDRAULIC FORCES THAT WILL REDUCE THIS VALUE

(CONCLUSION THIS SECTION): BASED UPON THE ASSUMED MATERIAL PROPERTIES AND DRY CONDITIONS THE "STATIC" FACTOR OF SAFTY OF THE LANDFILL COVER SYSTEM IS APPROXIMATELY 1.47

FORM 1 '84 (Single Sheets) ANSI (Padded) NEBS Inc Groton Mass 01471 To Order PHONE TOLL FREE 1 800 225 6380

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel. 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 14 OF
CALCULATED BY LJM DATE 4-6-94
CHECKED BY DATE
SCALE

EVALUATE THE CAP LINING STABILITY CONSIDERING EXCEPTIONALLY HEAVY RAINS WITH POTENTIAL SEEPAGE PARALLEL TO SLOPE.

USE INFINITE SLOPE THEORY WITH WATER FLOWING AS DERIVED BY YANG H. HUANG IN STABILITY ANALYSIS OF EARTH SLOPES

$$F = (1 - r_u)\frac{\tan\phi}{\tan\alpha}$$

F.S = 1.34 see PG 10

FOR DESIGN: $\phi = 24°$ INTERFACE GEOMEMBRANE/SOIL

SLOPE ANGLE $\alpha = 18.4°$

r_u = PORE PRESSURE RATIO

$\gamma_{SAT.} = 118\ \#/FT^3$ LOOSES STATE GIVES LOWEST F.S.

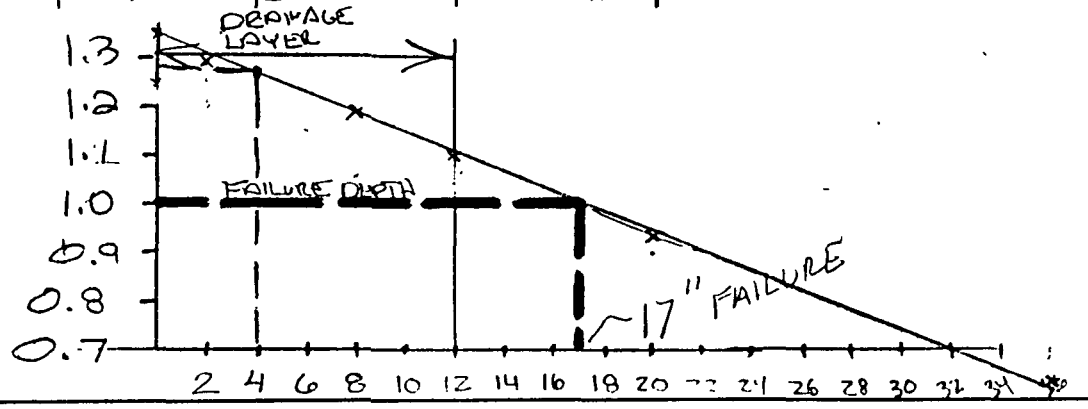
$h = 3\ FT$

$$r_u = \frac{u}{\gamma h}$$

u = PORE WATER PRESSURE; γ IS THE UNIT WEIGHT OF SOIL, h = depth OF POINT BELOW SOIL SURFACE.

VARY r_u FROM DRY TO FULL FLOWING LINER COVER

DEPTH OF WATER FLOWING ABOVE LINER	PORE WATER PRESSURE w × 62.4 =	r_u	$(1 - r_u)$	F.S.
2" ≈ 0.1667	10.4 #/ft²	0.0294	0.970	1.29 ← TRC RESULTS OF INFILTRATION MODEL
4" ≈ 0.333	20.7 " "	0.0585	0.941	1.26
6" ≈ 0.50	31.2 " "	0.0881	0.911	1.22
8" ≈ 0.67	41.8 " "	0.1181	0.882	1.18
12" ≈ 1.0	62.4 " "	0.1763	0.823	1.10
20" ≈ 1.67	104.2 " "	0.2944	0.705	0.94
36" ≈ 3.0	187.2 " "	0.5288	0.471	0.63



CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel. 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 15 OF
CALCULATED BY LJM DATE 4-6-94
CHECKED BY DATE
SCALE

LONG TERM GROUNDWATER ABOVE GEOMEMBRANE —
INFORMATION WAS GIVEN TO THIS OFFICE BY TRC IN REGARDS TO MAX. DEPTH OF WATER WITHIN THE DRAINAGE LAYER ON TOP OF THE GEOMEMBRANE. THIS ESTIMATE BASE UPON COMPUTER MODEL AN IS ON THE ORDER OF ±2". FOR LONG TERM DESIGN ASSUME 4" MAX.

THIS 4" MAX DEPTH OF FLOW WOULD REDUCE THE FACTOR OF SAFTY FROM 1.34 TO 1.26 IN THE THE INFINITE SLOPE MODEL AND IF WE APPLY THE SAME REDUCTION FACTOR IN THE SECOND MODEL WE HAVE 1.47 TO 1.38.

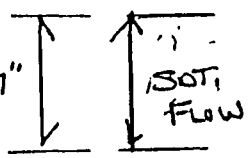
SHORT TERM GROUNDWATER ABOVE GEOMEMBRANE —

THIS SHORT TERM IS CONSIDERED DURING CONSTRUCTION
ASSUME POROSITY OF 0.40
ASSUME NATURAL WATER FILLED POROSITY OF 0.15
AVAILABLE POROSITY FOR RAINWATER ≈ 0.24

FAILURE TO ACCURE AT ±17" OF SATURATED SOIL

Table 4.2
Values of specific yield for various geologic materials (from Johnson, 1967)

Material	Specific yield (%)
Gravel coarse	23
Gravel medium	24
Gravel fine	25
Sand coarse	~~27~~
Sand medium	28
Sand, fine	23
Silt	8
Clay	3
Sandstone fine grained	21
Sandstone, medium grained	27
Limestone	14
Dune sand	38
Loess	18
Peat	44
Schist	26
Siltstone	12
Till, predominantly silt	6
Till predominantly sand	~~16~~
Till, predominantly gravel	16
Tuff	21



$1.41' \times 0.24 = 0.34' = \underline{\underline{4.1}}$" OF RAINWATER

VERY CRITICAL AT OR NEAR DISCHARGE POINTS AT TOE OF SLOPE, WHERE HYD. GRADIENT IS MUCH LESS THAN 3:1

SUMMARY THIS SECTION: LONG TERM STABILITY OF THE CAP SYSTEM (BASE ON TRC MODEL) SUBJECTED TO GROUNDWATER FLOW PARALLEL TO SLOPE WILL REDUCE THE COVER FACTOR OF SAFTY TO BETWEEN 1.26 TO 1.38.

DURING CONSTRUCTION A HEAVY RAIN ON THE DRAINAGE LAYER WITHOUT THE FULL COVER SECTION IN PLACE TO DIVERT RAIN INFILTRATION, MAY CAUSE INSTABILITY OF THE COVER SYSTEM. CONSTRUCTION PROCEDURES IMPORTANT.

FORMS + SYSTEMS Telephone (617) 749-1140 Fax (617) 749-1141 (NE THIS) INC. Groton, Mass 01471 To Order PHONE TOLL FREE 1-800 225-6300

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 16 OF
CALCULATED BY LJM DATE 4-6-94
CHECKED BY DATE
SCALE

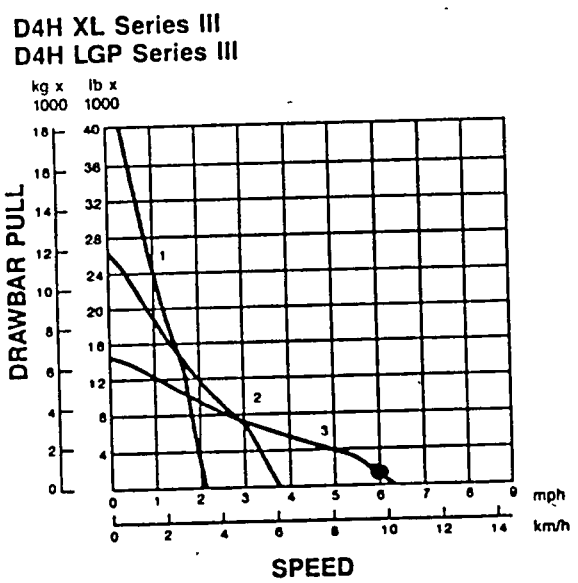
EVALUATE THE CAP LINING STABILITY DUE TO DYNAMIC STRESSES DUE TO INSTALLATION TRAFFICING AND MAINTAINANCE TRAFFICING

INSTALLATION TRAFFICING

"ASSUME" LARGEST MACHINE ALLOWED ON SLOPE WILL BE A

REF: CATERPILLAR PERFORMANCE HANDBOOK EDITION 24

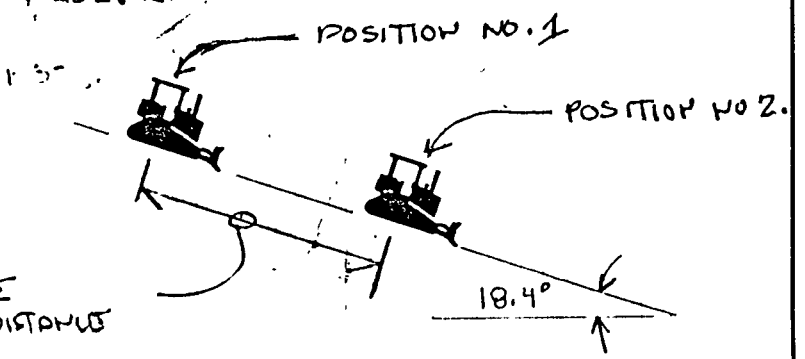
DOZER: D4H CATERPILLAR OR EQUIV.
OPERATING Weight 25,750 lb ≈ 12.9 TONS
GROUND PRESSURE 6.73 psi
LOW GROUND PRESSURE 4.41 psi



ASSUME WORST CASE: THE OPERATOR IS IN THIRD GEAR AND THEN PUT IT IN REVERSE.

USE: 6 mph
SLOPE: 18.4°
WT = 25,750 lb

USE: KINETIC ENERGY



ASSUME STOPPING DISTANCE VARIES

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB Mc ALLISTER POINT LNDUPNV
SHEET NO 17 OF
CALCULATED BY LJM DATE 4-6-94
CHECKED BY DATE
SCALE

POSITION 1: $V_1 = \left(\frac{6.0\,mi}{h}\right)\left(\frac{5280\,FT}{1\,mi}\right)\left(\frac{1\,h}{3600\,s}\right) = 8.8\,FT/sec$

$T_1 = \frac{1}{2} m V_1^2 = \frac{1}{2}(25{,}750\,lb) \times \frac{1\,lbm}{32.2\,lb_f} \times 8.8^2 \frac{FT}{sec}$

$= 30964\ FT \cdot lb$

POSITION 2: $V_2 = 0 \quad T_2 = 0$

WORK $U_{1\to2} = -Fx + (25{,}750 \sin 18.4)x =$ 8127.96

ASSUME STOPPING DISTANCE OF 1 FT

$-F(1) + 8128(1) =$

PRINCIPLE OF WORK AND ENERGY

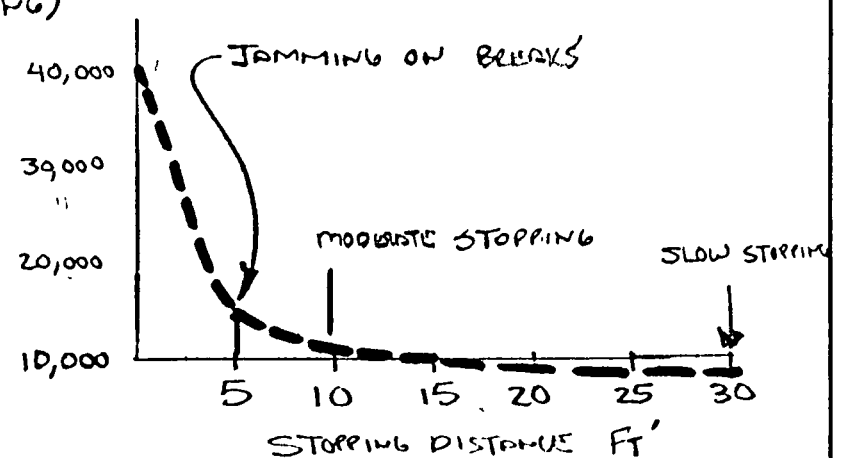
$T_1 + U_{1\to2} = T_2$

$30964\ FT \cdot lb + (-F + 8128) = 0$

$30964 - F + 8128 = 0$

$F = 39{,}092\ lb$

STOPPING DISTANCE	FORCE (BRAKING)
1	39,092
5	14,320
10	11224
15	10192
20	9676
25	9366
30	9160



THE MAX. FORCE DEVELOPED BY THE INTERFACE OF SOIL TO DOZER TRACK IS THE COEFF. OF TRACTION × WT. OF DOZER.
USE TAN ϕ = 0.62

$0.62 \times 25{,}750\,lb = 15{,}965\,lb$

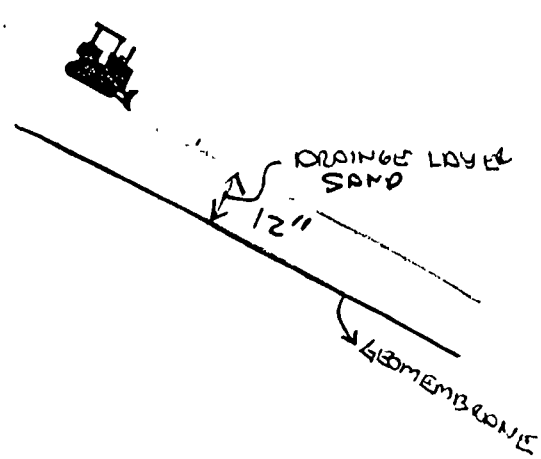
Copyright © 2001 Eaton Stationery Products Published by Nebs Inc. Groton, Mass 01471 To Order PHONE TOLL FREE 1 800 225 6380

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers ••Planners ••Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB MCALLISTER POINT LANDFILL
SHEET NO 18 OF
CALCULATED BY LJM DATE 4-6-94
CHECKED BY DATE
SCALE

① DEFINE DRIVING FORCE

W_S = WEIGHT OF COVER MATERIAL
W_T = WEIGHT OF VEHICLE
F_B = VEHICLE BRAKING FORCE



② DEFINE RESISTING FORCES

F_R = FRICTIONAL FORCE @
$(W_T + W_S) \times \cos\beta \tan\delta_{min}$

δ_{min} = IS THE MIN. FRICTION INTERFACE ANGLE
β = SLOPE ANGLE IN DEGREES

FACTOR OF SAFTY

$$F.S. = \frac{\text{RESISTING FORCES}}{\text{DRIVING FORCES}} = \frac{F_R}{(W_S + W_V)\sin B + F_B}$$

GIVEN: EQUIPMENT = 13 TON DOZER
$\delta_{min} = 24^\circ$
ASSUMED TRAVEL PATH WIDTH × LENGTH × THICKNESS
WIDTH = WIDTH OF DOZER 7'-6"
LENGTH = UPPER SLOPE 70'
THICKNESS = 12" ≈ 1'
$\gamma_{moist} = 126^{\#}/FT^3$

DRIVING FORCE

$$W_S = \frac{126^{\#}}{FT^3} \times 7.5' \times 1' \times 70' = 66150 \text{ lb}$$

$W_T = 25{,}750$ lb
$F_B = 15{,}965$ lb (JAMMING OF BRAKES)

$(66150 \text{ lb} + 25750)\sin 18.4 = 29008 \text{ lb} + 15{,}965$
$= 44973$ lbs

RESISTING FORCE

$$F_R = (66150 + 25{,}750)\cos 18.4^\circ \times \tan 24^\circ = 38824 \text{ lb}$$

Engineering Supplies (NEES) Inc. Groton, MASS 01471 To Order PHONE TOLL FREE 1 (800) 225 6380

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel. 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 19 OF
CALCULATED BY LJM DATE 4-6-94
CHECKED BY DATE
SCALE

$$F.S. = \frac{38824 \text{ lb}}{44973 \text{ lb}} = 0.86$$

FAILURE OF SLOPE

TRY LONGER STOPPING DISTANCE SAY 20'

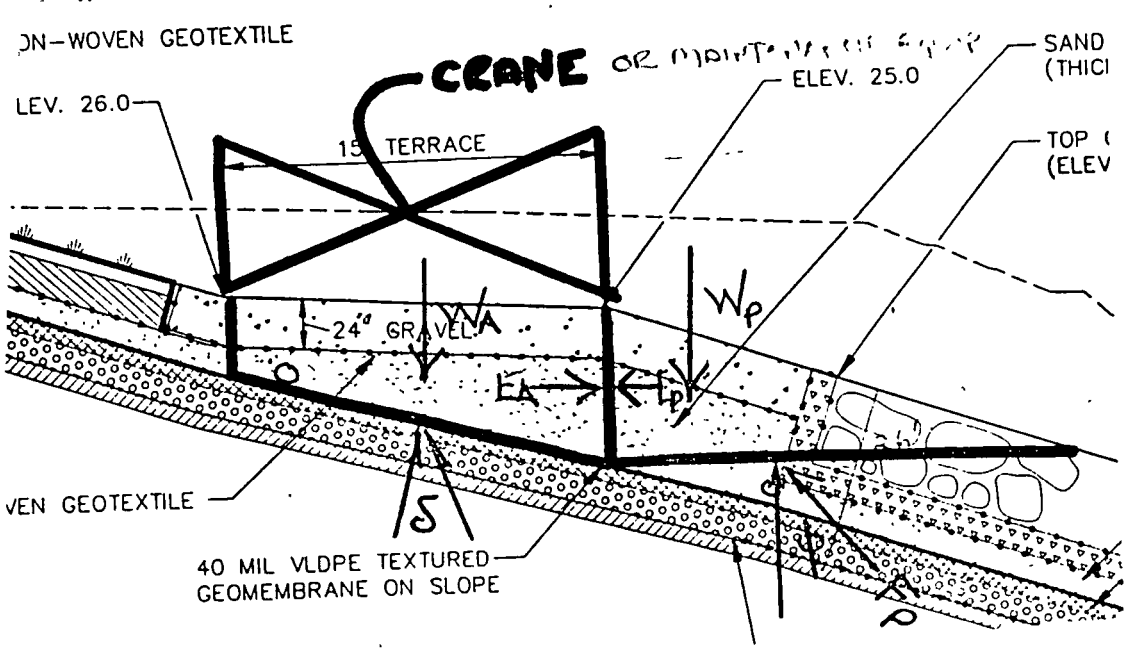
DRIVING FORCE 29008 lb + 9676 = 38684 lb
RESISTING FORCE 38824 lb

$$FS = \frac{38824}{38684} = 1.0$$

RESULTS, STOPPING DISTANCE WILL AFFECT THE SLOPE STABILITY DURING CONSTRUCTION.

SUMMARY THIS SECTION: DURING CONSTRUCTION THE CONTRACTOR SHOULD NOT BE ALLOWED TO USE HEAVY EQUIPMENT ON SLOPES AND CONTROLL THE OPERATION OF THESE EQUIPMENT AS NOT TO DEVELOPE FORCES THAT WILL CAUSE DAMAGE OR FAILURE OF THE COVER SECTION

MAINTENANCE OF ROCK REVETMENT



PRODUCT 204 1 (Single Shrubs) 205 1 (Padded) Nevis Inc Groton Mass 01471 To Order PHONE TOLL FREE 1 800 225 6320

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers ••Planners ••Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

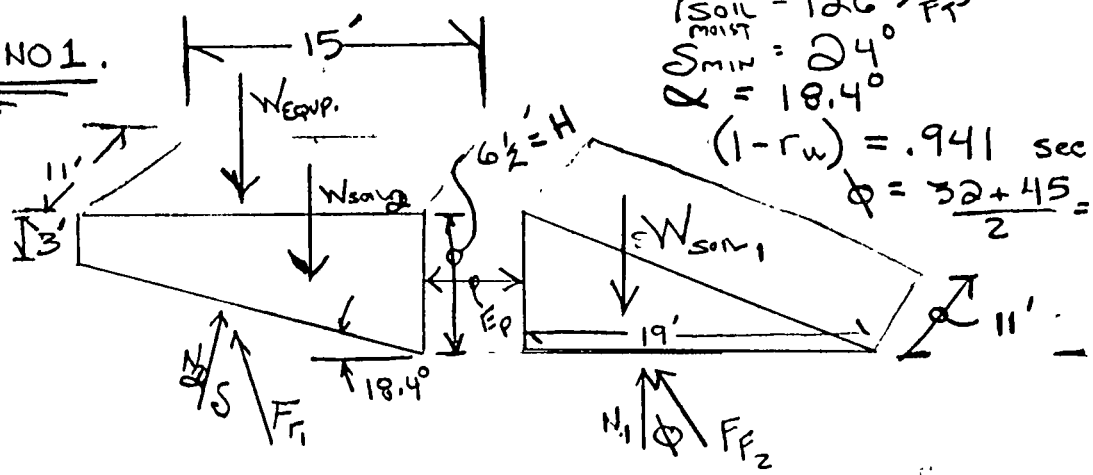
JOB McALLISTER POINT LANDFILL
SHEET NO 20 OF
CALCULATED BY LJM DATE 4-6-94
CHECKED BY DATE
SCALE

REF: CATERPILLAR PERFORMANCE HANDBOOK ED. 24

ASSUME WT 150,520 lbs EQUIL. TO 245 HYD. EXCAVATOR.
WIDTH = 11'

MODEL NO 1.

$\gamma_{SOIL\ MOIST} = 126\ \#/FT^3$
$\delta_{MIN} = 24°$
$\alpha = 18.4°$
$(1-r_u) = .941$ see sheet 14
$\phi = \frac{32+45}{2} = 38°$



$W_{EQUIP} = 68,420$ lbs.

$W_{SOIL_2} = \frac{(6.5'+3')}{2} \times 11'$ WIDE MACHINE $\times 15' \times 126\ \#/FT^3 = 98752$ lbs

$W_{SOIL_1} = \frac{1}{2} \times 6\frac{1}{2} \times 19 \times 11' \times 126\ \#/FT^3 = 85,585$ lbs $= 7780$ lb/FT

ASSUME FORCE E_P ACTING BETWEEN THE TWO BLOCKS IS HORIZONTAL

METHOD FOR SOLUTION USE TRAPEZOIDAL CROSS SECTION AS DERIVED IN YANG H. HUANG "STABILITY ANALYSIS OF EARTH SLOPES" PG 75, 76

$$a_1 F^2 + a_2 F + a_3 = 0$$

$a_1 = a_4 \sin\alpha$

$a_2 = -\left\{\left[(1-r_u)\cos\alpha\right](a_4+a_5)\tan\phi\right\}$

$a_3 = -B\sin\alpha\tan\bar{\phi}\left[(1-r_u)\frac{a_5}{B}\tan\bar{\phi}\right]$

$a_4 = \frac{W_2}{\gamma H^2}$

$a_5 = \frac{W_1}{\gamma H^2}$

Inc. Groton, Mass. 01471 To Order PHONE TOLL FREE 1-800-225-6380

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers ▪ Planners ▪ Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel. 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 21 OF
CALCULATED BY LJM DATE 4-6-94
CHECKED BY DATE
SCALE

$W_2 = W_{soil_2} + W_{equip} = 98752 + 150{,}520 \text{ lbs} = 249{,}272 \text{ lbs}$

$W_2/F_T = 249{,}272/11 = 22{,}661$

$a_4 = \dfrac{22661}{126 \times 6.5^2} = 4.26$

a $a_1 = 4.26 \sin 18.4^\circ = 1.34$

b $a_2 = -\left\{\left[0.941 \cos 18.4^\circ\right](4.26 + 1.46) \tan 24^\circ\right\} = -2.27$

$a_5 = \dfrac{7780}{126 \times 6.5^2} = 1.46$

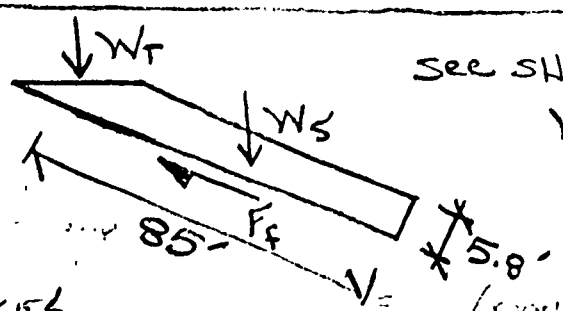
$a_3 = -2.9' \sin 18.4 \tan 24^\circ \left[0.941\left(\dfrac{1.46}{2.9}\right) \tan 24^\circ\right]$

c $a_3 = -.086$

$$F.S. = \frac{-b\sqrt{b^2 - 4ac}}{2a}$$

$$\frac{-(-2.27) \pm \sqrt{(-2.27)^2 - 4(1.34)(-.086)}}{2 \times 1.34} = \frac{4.64}{2.68} = 1.73$$ NOT LOWEST FAILURE PLAT

MODEL NO 2



SEE SHEET 18

$W_S = 11' \times 5.8' \times 85' \times 126 \text{ lb/ft}^3$
$= 683{,}298 \text{ lb}$

$W_T = 150{,}520 \text{ lb}$

(DON'T ADD W_T TO RESISTING FORCES AS THIS WT. IS NOT EVENLY DISTRIBUTED ACCROSS SURFACE)

RESISTING FORCES

F_r = FRICTIONAL FORCE

$(W_S) \cos \beta \tan \delta_{min} = 683{,}298 \text{ lbs} \times \cos 18.4 \times \tan 24^\circ$
$= 288{,}670 \text{ lb}$

DRIVING FORCE

$(W_T + W_S) \sin 18.4^\circ = (150{,}520 + 683298) \sin 18.4 = 263194 \text{ lb}$

$F.S. = \dfrac{288670 \text{ lb}}{263194 \text{ lb}} = 1.09$ CLOSE TO FAILURE DOES NOT INCLUDE DYNAMIC EFFECTS

CONCLUSION - SIZE OF MACHINE SHOULD BE LIMITED ON MAINTANENCE DRIVE, LESS THAN 20 TONS TO INCREASE F.S. TO 1.26

FORM CT 204-1 (Single Sheets) 8.5 1 (Padded) NCTS Inc. Groton, Mass. 01471 To Order PHONE TOLL FREE 1 800 225 6380

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
P.O. Box 866 1764 Foxon Road
North Branford, CT 06471
Tel. 203/481-8749 Fax 203/488-5729

JOB MCALLISTER POINT LANDFILL
SHEET NO. 22 OF
CALCULATED BY LJM DATE 4-2-91
CHECKED BY DATE
SCALE

STATIC STABILITY ANALYSIS FOR ROTATIONAL SLOPE STABILITY (GLOBE)

METHOD OF ANALYSIS: STABL COMPUTER CODE
BY: PURDUE UNIVERSITY
DEPT OF CIVIL ENGINEERING
WEST LAFAYETTE, INDIANA 47907

GEOMETRY: THREE CROSS-SECTIONS WERE SELECTED FOR ANALYSIS. THESE CROSS-SECTIONS WERE TAKEN THROUGH THE LANDFILL AT LOCATIONS INDICATED ON X-SECTION I.D. PLAN IN APPENDIX "B". THE FOLLOWING LIST IS WHERE INFORMATION WAS OBTAINED TO GENERATE THESE CROSS SECTIONS:

- PROPOSED GRADING TAKEN FROM PLANS C-5 AND C-6 by TRC ENTITLED "CAP MCALLISTER POINT LANDFILL FINAL GRADING PLAN (NORTH) AND FINAL GRADING PLAN (SOUTH).
- BEDROCK PROFILE TAKEN FROM TRC BEDROCK CONTOUR MAP (SEE ATTACHMENT "8")
- GROUNDWATER PROFILE TAKEN FROM TRC UPPER SURFACE GROUND WATER CONTOUR MAP (SEE ATTACHMENT "2")

MATERIAL PROPERTIES: SEE STATIC STABILITY ANALYSIS FOR LANDFILL COVER SYSTEM FOR "ASSUMED MATERIAL PROPERTIES INFORMATION" PG 2-10

COMPUTER OUTPUT RESULTS: (SEE APPENDIX "C" FOR COMPUTER OUTPUT INFO.)

STATIC CONDITION

CROSS SECTION NO.	LOWEST ROTATIONAL FACTOR OF SAFETY WITH COHESION	LOWEST ROTATIONAL F.O.S. WITHOUT COHESION
A-A	2.3	1.62
B-B	2.12	1.53
C-C	1.98	1.45

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers ••Planners ••Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB Mc ALLISTER TOWN LANDFILL
SHEET NO 23 OF
CALCULATED BY LJM DATE 4-8-94
CHECKED BY DATE
SCALE

CHECK COMPUTER RESULTS WITH SIMPLIFIED METHODS (STABILITY CHARTS)

REF: CHARTS FROM YANG H. HUANG STABILITY ANALYSIS OF EARTH SLOPES.

① BISHOP AND MORGENSTERN'S CHARTS

LANDFILL PROPERTIES (GEOMETRY TAKEN FROM CROSS SECTION C-C).

$\bar{c} = 200$ #/FT³ $\qquad \frac{\bar{c}}{\gamma H} = \frac{200}{100(48')} = 0.0417$

$\phi = 23°$

$\gamma = 100$ #/FT³

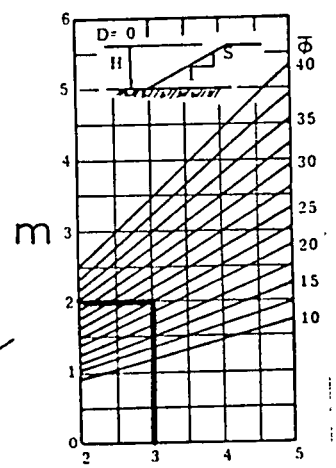
$H = 48'$ $\qquad$ WATER IN LANDFILL IS JUST ON TOP OF WITHIN LEDGE ROCK

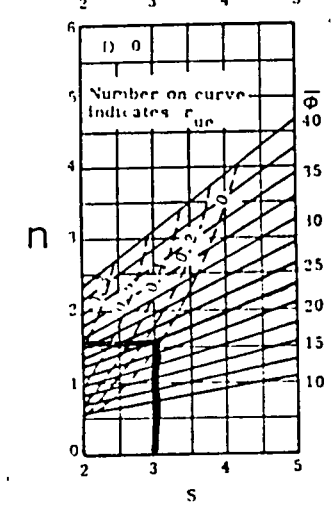
$D = 0$ $\qquad F = m - r_u n$

$S = 3$ $\qquad$ @ $c/\gamma H = 0.05$ = m = 2.05 @ 0.0417 m = 1.95

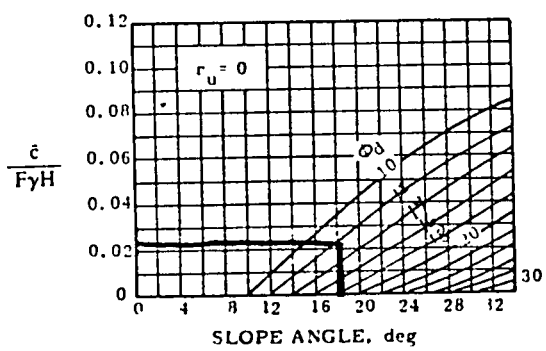
@ $c/\gamma H = 0.025$ = m = 1.75

$F = 1.9 - 0(n) = \underline{\underline{1.95}}$





② SPENCER'S CHARTS



Stability chart for different pore pressure ratios. (After Spencer, 1967)

NOTE: ASSUME THAT THE LEDGE OF FIRM STRATA IS AT A GREAT DEPTH BELOW THE SURFACE

ASSUME F.S. = 1.9

$\frac{\bar{c}}{F.\gamma H} = \frac{200}{1.9(100)48} = 0.0219$

$\phi_d = \tan^{-1}(\tan\phi/F.S.) = \tan^{-1}(\tan 23/1.9) = 12.1$

FROM CHART SLOPE ANGLE = 18.4°

FIGURE 7 5 Stability chart for $\frac{\bar{c}}{\gamma H} = 0.05$ (After Bishop and Morgenstern, 1960)

To Order PHONE TOLL FREE 1 800 225 6380

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB MCALLISTER TOWN LANDFILL
SHEET NO 24 OF
CALCULATED BY LJM DATE 4-8-94
CHECKED BY DATE
SCALE

(3) BY BRIAN F. COUSINS

$H = 48'$
$\phi = 23°$
$C = 200\ \text{lb/ft}^2$
$\gamma = 100\ \text{lb/ft}^3$
$r_u = 0$

THUS: $\frac{C}{\gamma H} = \frac{200}{100(48)} = 0.0417$

$\lambda_{cq} = \frac{\gamma H \tan\phi'}{C} = \frac{(100)(48)(\tan 23°)}{200} = 10.2$

$D = 1,\ N_F = 45$ THUS $F = 45 \times .0417 = \underline{\underline{1.88}}$

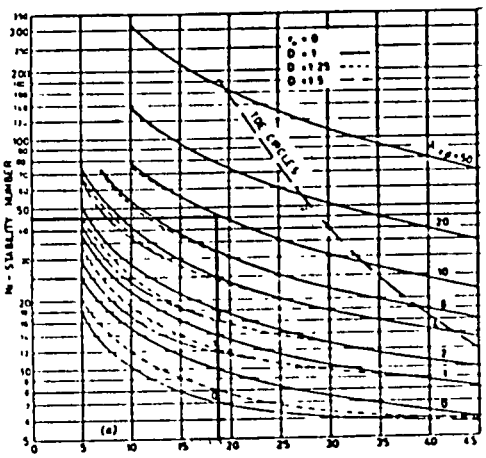


FIG. 5.—Stability Numbers for Depth Factor D = 1, 1.25, 1.5, and: (a) r_u = 0; (b) r_u = 0.25; (c) r_u = 0.5

(SUMMARY STABILITY CHARTS FOR CIRCULAR FAILURE

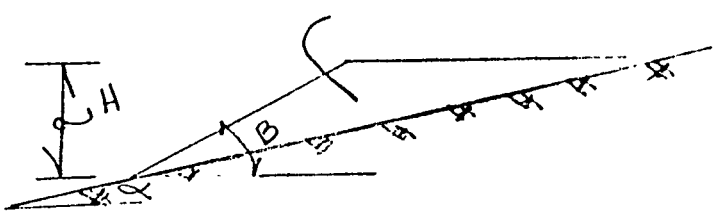
DEVELOPER'S NAME	FACTOR OF SAFETY
BISHOP AND MORGENSTERN	1.95
SPENCER'S	1.90
COUSIN'S	1.88

AVG = 1.91

NOTE: CHARTS COMPARE WELL WITH (P.C. STABLE) COMPUTER CODE

CHECK POTENTIAL SLIDING ON ROCK SLOPE

USE TRIANGULAR FILLS ON ROCK SLOPES REF. HUANG 1977, 1978)



$H = 48'$
$\alpha = 8°$ max
$B = 18.4°$

$\phi = 23°$
$C = 200\ \text{lb/ft}^2$
$\gamma = 100\ \text{lb/ft}^3$
} LAND FILL MATERIAL

$\phi = 28°$
$C = 0\ \text{lb/ft}^2$
$\gamma = 100\ \text{lb/ft}^3$
} DECOMPOSED ROCK LAYER

$$F = N_s \left[\frac{\bar{C}}{\gamma H} + \frac{(1 - r_u)\tan\phi}{N_f} \right]$$

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB McALLISTER FOOT LANDFILL
SHEET NO 25 OF
CALCULATED BY LJM DATE 4-8-94
CHECKED BY DATE
SCALE

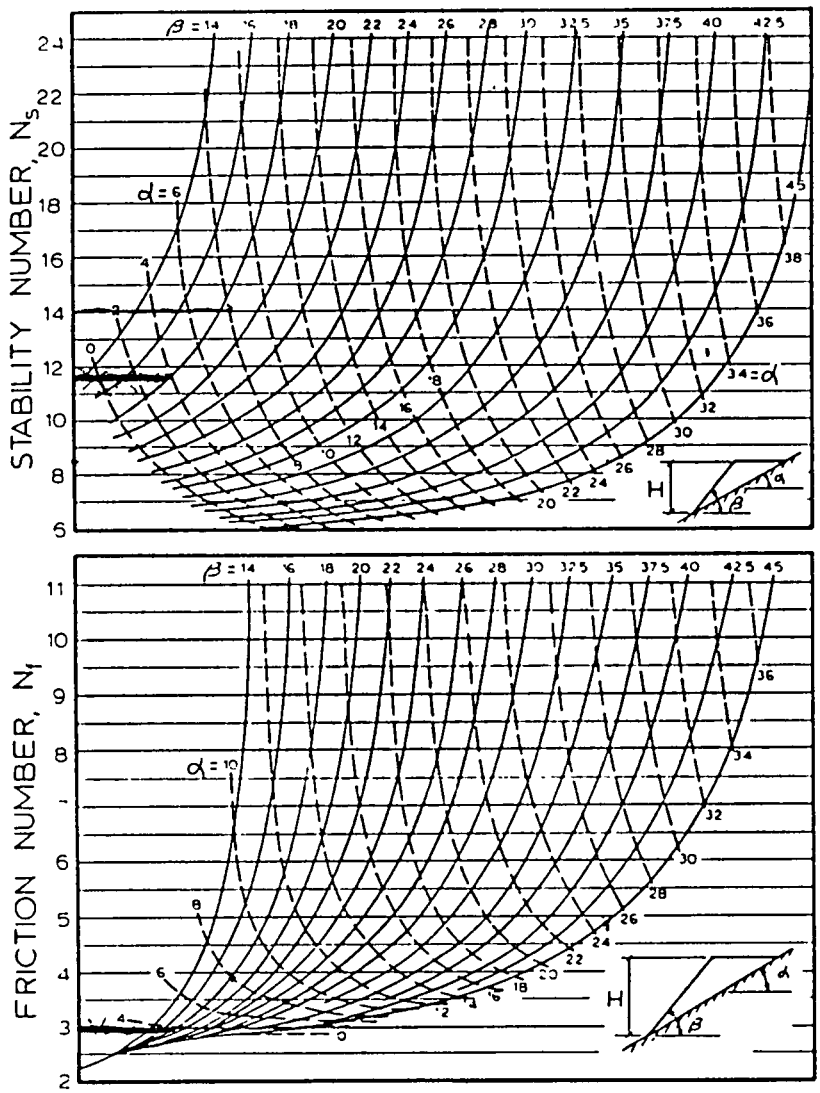


FIGURE 7 12 Stability chart for spoil banks and hollow fills.

FROM CHARTS

$N_s = 14.0$

$N_f = 3.8$

$$F = 14.0\left[\frac{\overset{.0417}{200}}{100(48)} + \frac{\overset{.1117}{(1-0)\tan 23}}{3.8}\right]$$

$F = 2.15$

MAKE CORRECTION

$F_c = \frac{0.0417}{0.1534} = 0.272 = 27\%$

$C_F = .97$

$F_c = 2.15 \times .97 = \underline{2.08}$

LANDFILL MATERIAL PROPERTIES

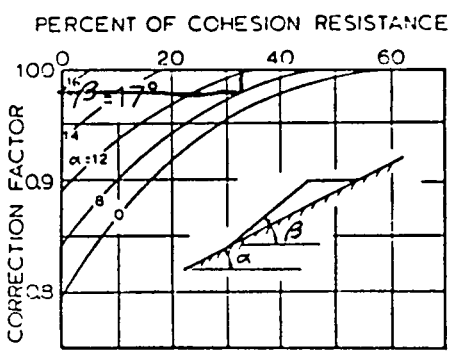


FIGURE 7 13. Chart for correcting factor of safety

ATTACHMENT NO. 1

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners ■ Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 1 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
SCALE

TABLE #1
Typical Values of Soil Index Properties

	Particle Size and Gradation				Voids(1)					Unit Weight(2) (lb./cu.ft.)						
	Approximate Size Range (mm)		Approx. D_{10} (mm)	Approx. Range Uniform Coefficient C_u	Void Ratio			Porosity (%)		Dry Weight			Wet Weight		Submerged Weight	
	D_{max}	D_{min}			e_{max} loose	e_{cr}	e_{min} dense	n_{max} loose	n_{min} dense	Min loose	100% Mod. AASHO	Max dense	Min loose	Max dense	Min loose	Max dense
GRANULAR MATERIALS																
Uniform Materials																
a. Equal spheres (theoretical values)	-	-	-	1.0	0.92	-	0.35	47.6	26	-	-	-	-	-	-	-
b. Standard Ottawa SAND	0.84	0.59	0.67	1.1	0.80	0.75	0.50	44	33	92	-	110	93	131	57	69
c. Clean, uniform SAND (fine or medium)	-	-	-	1.2 to 2.0	1.0	0.80	0.40	50	29	83	115	118	84	136	52	73
d. Uniform, inorganic SILT	0.05	0.005	0.012	1.2 to 2.0	1.1	-	0.40	52	29	80	-	118	81	136	51	73
Well-graded Materials																
a. Silty SAND	2.0	0.005	0.02	5 to 10	0.90	-	0.30	47	23	87	122	127	88	142	54	79
b. Clean, fine to coarse SAND	2.0	0.05	0.09	4 to 6	0.95	0.70	0.20	49	17	85	132	138	86	148	53	86
c. Micaceous SAND	-	-	-	-	1.2	-	0.40	55	29	76	-	120	77	138	48	76
d. Silty SAND & GRAVEL	100	0.005	0.02	15 to 300	0.85	-	0.14	46	12	89	-	146(3)	90	155(3)	56	92
MIXED SOILS																
Sandy or Silty CLAY	2.0	0.001	0.003	10 to 30	1.8	-	0.25	64	20	60	130	135	100	147	38	85
Skip-graded Silty CLAY with stones or rk fgmts	250	0.001	-	-	1.0	-	0.20	50	17	84	-	140	115	151	53	89
Well-graded GRAVEL, SAND, SILT & CLAY mixture	250	0.001	0.002	25 to 1000	0.70	-	0.13	41	11	100	140	148(4)	125	156(4)	62	94
CLAY SOILS																
CLAY (30%-50% clay sizes)	0.05	0.5μ	0.001	-	2.4	-	0.50	71	33	50	105	112	94	133	31	71
Colloidal CLAY (-0.002 mm: 50%)	0.01	10Å	-	-	12	-	0.60	92	37	13	90	106	71	128	8	66
ORGANIC SOILS																
Organic SILT	-	-	-	-	3.0	-	0.55	75	35	40	-	110	87	131	25	69
Organic CLAY (30% - 50% clay sizes)	-	-	-	-	4.4	-	0.70	81	41	30		100	81	125	18	62

REF: TABLE NO. 1 & FIGURE 1
TAKEN FROM NAVFAC 0525-LP-300-7055
SOIL MECHANICS - DESIGN MANUAL 7.1
MAY 1982

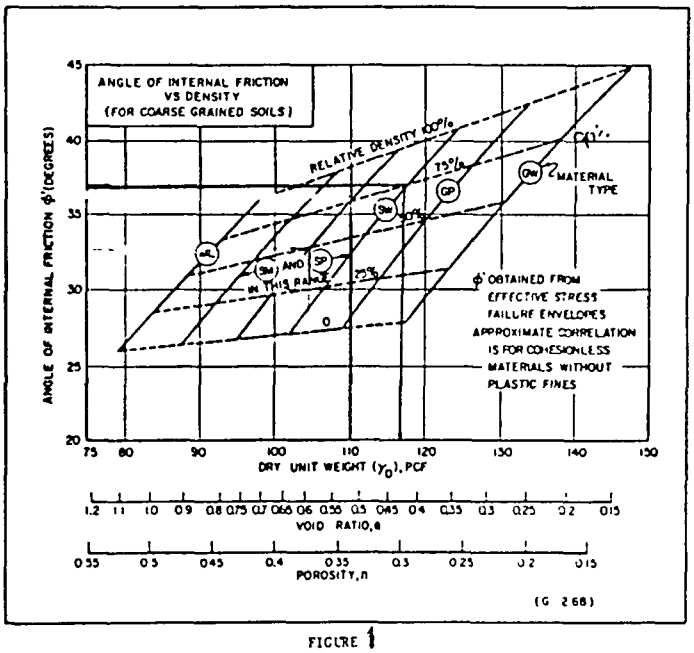


FIGURE 1
Correlations of Strength Characteristics for Granular Soils

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 2 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
SCALE

TABLE 2

TYPICAL PROPERTIES OF COMPACTED MATERIALS

REF: (NAVFAC DM-7, MARCH 1971)

Group symbol	Soil type	Range of maximum dry unit weight, pcf	Range of optimum moisture, percent	Typical value of compression: At 1.4 tsf (20 psi)	Typical value of compression: At 3.6 tsf (50 psi)	Typical strength characteristics: Cohesion (as compacted) psf	Cohesion (saturated) psf	ϕ (Effective stress envelope) degrees	Tan ϕ	Typical coefficient of permeability ft/min. (D698)	Range of CBR values (D1557)	Range of subgrade modulus k lb/cu in
				Percent of original height								
GW	Well graded clean gravels, gravel-sand mixtures	125 - 135	11 - 8	0.3	0.6	0	0	>38	>0.79	5×10^{-2}	40 - 80	300 - 500
GP	Poorly graded clean gravels, gravel-sand mix	115 - 125	14 - 11	0.4	0.9	0	0	>37	>0.74	10^{-1}	30 - 60	250 - 400
GM	Silty gravels, poorly graded gravel-sand-silt	120 - 135	12 - 8	0.5	1.1	.....	.....	>34	>0.67	$>10^{-6}$	20 - 60	100 - 400
GC	Clayey gravels, poorly graded gravel-sand-clay	115 - 130	14 - 9	0.7	1.6	.....	.....	>31	>0.60	$>10^{-7}$	20 - 40	100 - 300
SW	Well graded clean sands, gravelly sands	110 - 130	16 - 9	0.6	1.2	0	0	38	0.79	$>10^{-3}$	20 - 40	200 - 300
SP	Poorly graded clean sands, sand-gravel mix	100 - 120	21 - 12	0.8	1.4	0	0	37	0.74	$>10^{-3}$	10 - 40	200 - 300
SM	Silty sands, poorly graded sand-silt mix	110 - 125	16 - 11	0.8	1.6	1050	420	34	0.67	5×10^{-5}	10 - 40	100 - 300
SM-SC	Sand-silt clay mix with slightly plastic fines	110 - 130	15 - 11	0.8	1.4	1050	300	33	0.66	2×10^{-6}	.....	
SC	Clayey sands, poorly graded sand-clay mix	105 - 125	19 - 11	1.1	2.2	1550	230	31	0.60	5×10^{-7}	5 - 20	100 - 300
ML	Inorganic silts and clayey silts	95 - 120	24 - 12	0.9	1.7	1400	190	32	0.62	10^{-5}	15 or less	100 - 200
ML-CL	Mixture of inorganic silt and clay	100 - 120	22 - 12	1.0	2.2	1350	460	32	0.62	5×10^{-7}	.....	
CL	Inorganic clays of low to med. plasticity.	95 - 120	24 - 12	1.3	2.5	1800	270	28	0.54	10^{-7}	15 or less	50 - 200
OL	Organic silts and silt-clays, low plasticity	80 - 100	33 - 21	.....	.....	.....	.....	.....	...	.....	5 or less	50 - 100
MH	Inorganic clayey silts, elastic silts	70 - 95	40 - 24	2.0	3.8	1500	420	25	0.47	5×10^{-7}	10 or less	50 - 100
CH	Inorganic clays of high plasticity	75 - 105	36 - 19	2.6	3.9	2150	230	19	0.35	10^{-7}	15 or less	50 - 150
OH	Organic clays and silty clays	65 - 100	45 - 21	.....	.....	.....	.....	.....	...	.....	5 or less	25 - 100

Notes:

1. All properties are for condition of "standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density.
2. Typical strength characteristics are for effective strength envelopes and are obtained from USBR data.
3. Compression values are for vertical loading with complete lateral confinement
4. (>) indicates that typical property is greater than the value shown.

(...) indicates insufficient data available for an estimate

Inc Groton Mass 01471 To Order PHONE TOLL FREE 1 800

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB MCALLISTER POINT LANDFILL
SHEET NO 3A OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
SCALE

TABLE #3

RANGES OF TYPICAL ANGLES OF INTERFACE FRICTION FOR VARIOUS MATERIALS TESTED AT NORMAL COMPRESSIVE STRESSES LESS THAN 500 psf

INTERFACE	SMOOTH UNREINFORCED GEOMEMBRANE	TEXTURED GEOMEMBRANE	COMPACTED CLAY	COMPACTED SAND	NONWOVEN NEEDLEPUNCHED GEOTEXTILE	GEONET
SMOOTH UNREINFORCED GEOMEMBRANE	0°-15°	—	>5°-20°	15°-25°	10°-14°	10°-12°
TEXTURED GEOMEMBRANE	—	—	>10°-32°	20°-35°	25°-35°	7°-10°
COMPACTED CLAY	>5°-20°	>10°-32°	—	—	20°-35°	—
COMPACTED SAND	15°-25°	20°-35°	—	—	25°-35°	—
NONWOVEN NEEDLEPUNCHED GEOTEXTILE	10°-14°	25°-35°	20°-35°	25°-35°	17°-25°	10°-20°
GEONET	>10°-12°	7°-10°	—	—	10°-28°	—

REF: ASCE SEMINAR
SOIL LINERS AND COVERS FOR LANDFILLS
UPDATE 9-93

INTERFACE DIRECT SHEAR TEST RESULTS
MEASURED PEAK STRENGTH PARAMETERS

TABLE NO 4

Test Series Number	Interface Tested	Coefficient of Friction	Interface Friction Angle	Adhesion[1] (psf)
1	Trevira 1125 Geotextile/80-mil NSC Textured HDPE Geomembrane	0.62	32°	55
2	Drainage Sand/80 mil NSC Textured HDPE Geomembrane	0.81	39°	35
3	Compacted Clay/80-mil NSC Textured HDPE Geomembrane	0.78	38°	210

NOTE [1] The reported value of adhesion may not be the "true adhesion" of the interface an caution should be exercised in using this adhesion value for applications involvin normal stresses outside the range of stresses covered by the test

REF: FINAL REPORT DATED 31 AUG. 1991
GEOSYNTEC CONSULTANT TO
NATIONAL SEAL COMPANY
RE: INTERFACE DIRECT SHEAR
TESTING NSC TEXTURED
HDPE GEOMEMBRANE

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel. 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 3B OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
SCALE

TABLE NO. 5

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

October 13, 1992
File Number 91-130

Mr. Cirilo Thompson
ABB SUSA/DILLINGHAM - A Joint Venture
1100 Cornwall Road
Monmouth Junction, NJ 08852

RECEIVED
OCT 14 1992
PROJECT DEPT.

Subject: Liner Friction Testing - Gundle Materials

Dear Cirilo:

Based on testing conducted to-date on the above referenced materials, the following friction angles may be used in design:

TABLE NO 5.

Liner Type	Material Type	Friction Angle	Stable Slope*
VLDPE Smooth	Local Sand	18	4.4(H) to 1(V)
VLDPE Smooth	Crushed Sand	19	4.4(H) to 1(V)
VLDPE Rough	Local Sand	40	≤3.0(H) to 1(V)**
VLDPE Rough	Crushed Sand	45	≤3.0(H) to 1(V)**
PVC	Local Sand	21	3.9(H) to 1(V)
PVC	Crushed Sand	24	3.5(H) to 1(V)

*The above slopes are based on a Factor of Safety of 1.5
**The slope is controlled by factors other than the liner friction angle

I have also provided the PVC data to use for comparison purposes.

Please call me if you have any questions.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.

Scott W. Davidson, P.E.
Vice President
Florida Registration No. 31934

FAX # 1573

h01170g

8000 S. Orange Avenue (32809) Post Office Box 593000 Orlando, Florida 32859-3000 Phone (407) 855-3860 FAX (407) 859-8121

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel. 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 4 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
SCALE

Physical and Chemical Properties for Incinerator Residues in the Literature

A.1 SVPCS Engineering Properties of Batch Feed Municipal Incinerator Residue:

Natural water content	35.5%	63 = γ_m
Water content saturated	65.5%	77 = γ_s
Porosity , N	71.3%	
Dry Unit Weight	46.7 pcf	
Specific gravity 1#40 sieve	2.61	
Swelling 1#40 sieve	15-20%	
Shrinkage	negligible	
Permeability , K	3.9×10^{-4} fps	
Friction angle ϕ, direct shear	48°	
Saturated unit weight	91.2 calculated	

A.2 Continuous Feed Municipal Incinerator Residue, Norwalk

Proctor Compaction	γ_o = 92.5 pcf @WC=22.5% γ_1 = 120.0 pcf γ_s = 121.5 pcf
Specific Gravity	2.60
Void Ratio	0.75
Porosity	0.43
Permeability , K	1.0×10^{-3}
Friction Angle	ϕ = 39.1° average
Consolidation Data	Moderately Compressible, approx. 80% very rapid , remainder term, with C_c = 1.6×10^{-3}
Grain Size Distribution Lin	32% gravel size 68% sand size 0.5% silt size or smaller Well graded

A.2 Engineering Properties of Continuous Feed Municipal Incinerator Residue from Schoenberger and Purdon

Blow Count	3-8
Sieve Analysis	5-15% pass #200 Well graded
Friction Angle , direct shear	45°
Compressibility	"moderately compressible"
In place density	101 pcf (mean)
Compaction	101-102 pcf @ WC 20-21% (After Pequardt and Harrington)

REF: MASTER THESIS 76 - THE UNIVERSITY OF CONNECTICUT by LEOFFREY GUY JILLSON "MEASUREMENT OF THE ENGINEERING PROPERTIES OF MUNICIPAL INCINERATOR RESIDUES AND CONSIDERATION OF LEACHATE CHARACTERISTICS"

Inc. Groton Mass. 01471 To Order PHONE TOLL FREE 1 800

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel. 203/481-8749 Fax 203/488-5729

JOB MCALLISTER POINT LANDFILL
SHEET NO 5 OF
CALCULATED BY LTM DATE 4-2-94
CHECKED BY DATE
SCALE

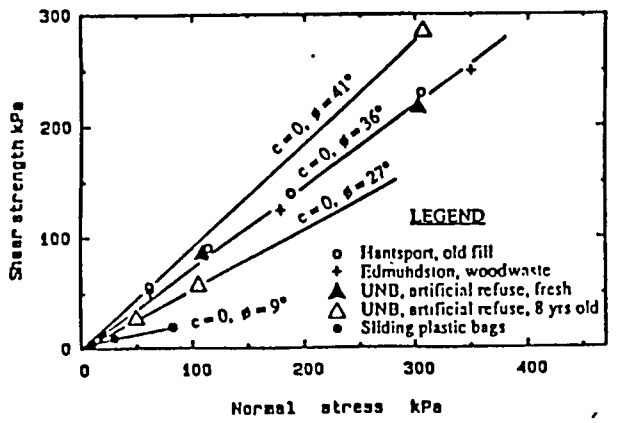


FIG. 9 – Large direct-shear tests on samples from old woodwaste/refuse fill in Hantsport, N.S., Fraser woodwaste stockpile in Edmundston, N.B., artificial UNB samples, and sliding garbage bags

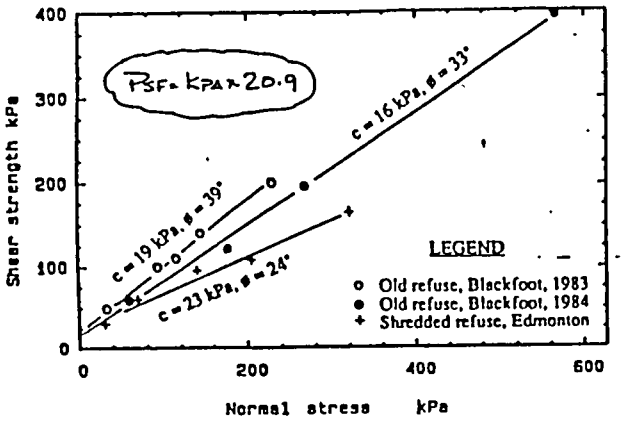


FIG. 8 – Large direct-shear tests on samples from old fill in Calgary and from fresh shredded fill in Edmonton

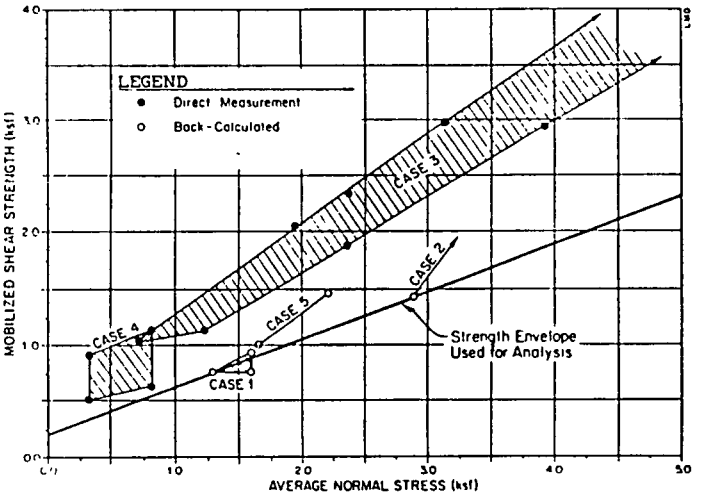


Figure 3 SUMMARY of MUNICIPAL SOLID WASTE STRENGTH DATA
(REFER TO TEXT FOR AN EXPLANATION OF EACH CASE)

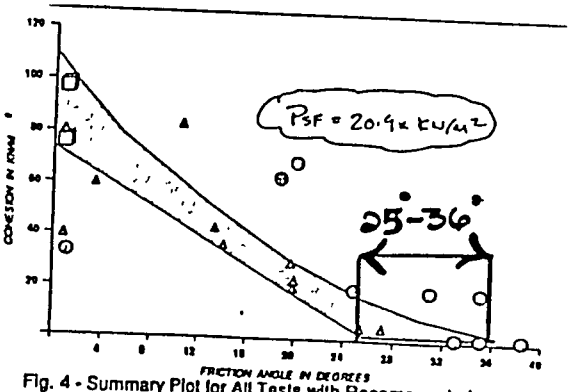


Fig. 4 - Summary Plot for All Tests with Recommended Parameters Shaded

REF: GEOTECHNICS OF WASTE FILL
ASTM STP 1989

Summary - Municipal Solid Waste Properties

Based on the data summarized on Figure 3, two conclusions were made. First, the strength of municipal solid waste is primarily frictional in nature. Second, the results of back analyses indicate a lower waste strength than the results of direct measurements. The reason for this difference is unknown, but could be the greater influence of peat like fibrosity on smaller scale direct measurements relative to back calculations from large scale failures or load tests. Alternatively, waste strengths back calculated from failures of landfills on soft foundations may be inaccurate because of uncertainties about the soil behavior (Case 1).

The strength envelope shown on Figure 3 was selected for use in the stability analyses presented in the following section. This strength envelope, defined by Mohr Coulomb parameters of C equal to 200 psf and Phi equal to 23 degrees, is a lower bound to the data. The envelope reflects the back calculated strength data and is therefore consistent with the stability analyses to be performed.

Note that in general, the various factors hypothesized at the beginning of this section have not been systematically proven or quantified. Therefore, it is not recommended that the strength parameters selected above be used by reference for other analyses. It is recommended that the general methodology of comparing available directly measured and back calculated data on a mobilized shear strength versus normal stress basis be used. Great care should be exercised in selecting waste strength parameters for use in the stability analysis of high landfills particularly when the anticipated stresses exceed the stress ranges for which data are available.

Excess pore pressures in the waste were assumed to be zero for all analyses because of the presence of the leachate collection system at the base of the landfill and reported high waste permeabilities (Landva and Clark, 1990). Note that research in progress by the second author of this paper indicates that waste permeability may decrease significantly at high confining pressures.

A waste unit weight of 45 pcf was used for the stability analysis. This value was provided by the owner of the landfill based on measurements of waste and daily cover weights and surveyed airspace volumes. The selected unit weight appeared to be consistent with values summarized by Bromwell (1978) but toward the lower end of data reported by Landva and Clark (1990) based on measurements from large test pits (approximately 10 cubic yards). The influence of the waste unit weight on

REF: VOL. 2 GEOTECHNICAL SPECIAL PUBLICATION NO. 31
"STABILITY AND PERFORMANCE OF SLOPES AND EMBANKMENTS - II"
PG 1229

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers • Planners • Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB MCALLISTER POINT LANDFILL
SHEET NO 60 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
SCALE

TABLE III
Strength data for intact rock

Rock type	Uniaxial compressive strength MPa		
	Min.	Max.	Mean
Chalk	1,1	1,8	1,5
Rocksalt	15	29	22,0
Coal	13	41	31,6
Siltstone	25	38	32,0
Schist	31	70	43,1
Slate	33	150	70,0
Shale	30	172	95,6
Sandstone	40	179	95,9
Mudstone	32	152	99,3
Marble	60	140	112,5
Limestone	69	180	121,8
Dolomite	83	165	127,3
Andesite	127	138	128,5
Granite	153	233	188,8
Gneiss	139	256	195,0
Basalt	168	359	252,7
Quartzite	200	304	252,0
Dolerite	227	319	280,3
Gabbro	290	326	298,0
Banded ironstone	125	175	450,0
Chert	587	683	635,0

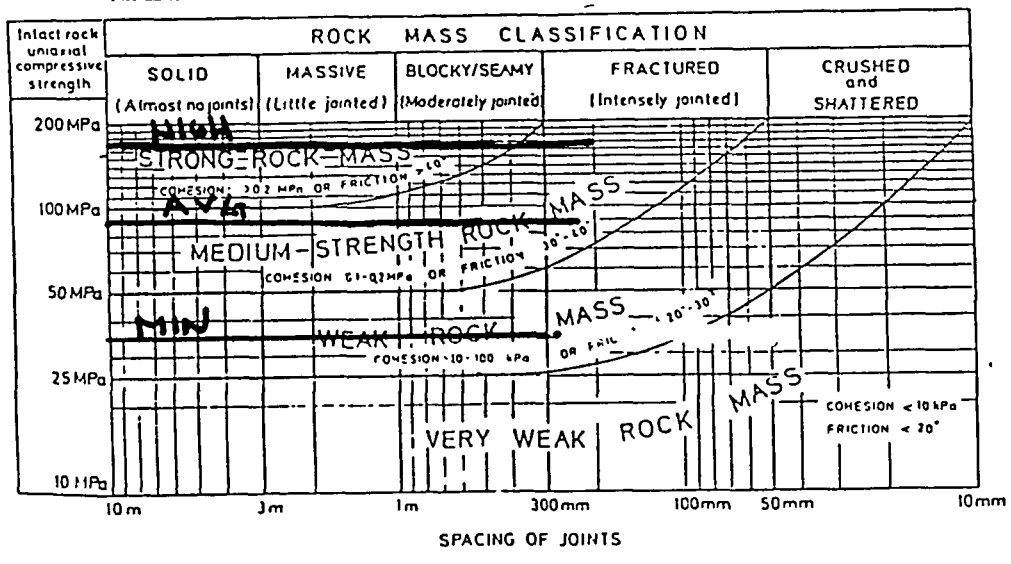


Fig 1 — Strength diagram of jointed rock masses (modified after Muller)

CRISCUOLO/SHEPARD ASSOCIATES, PC
Engineers ▪ Planners ▪ Surveyors
PO Box 866 1764 Foxon Road
North Branford, CT 06471
Tel 203/481-8749 Fax 203/488-5729

JOB McALLISTER POINT LANDFILL
SHEET NO 7 OF
CALCULATED BY LJM DATE 4-2-94
CHECKED BY DATE
SCALE

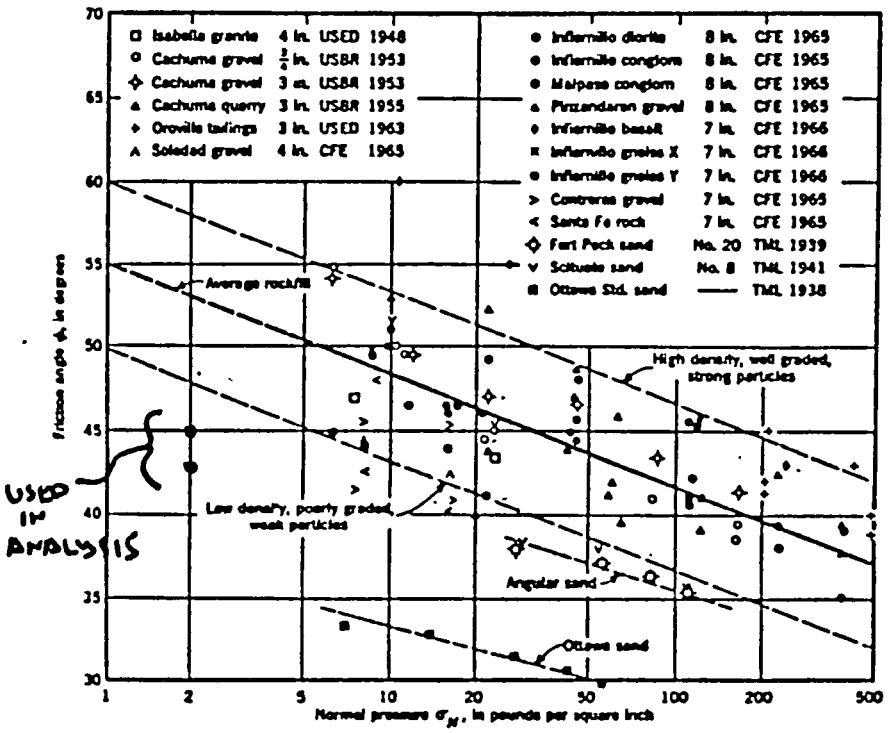
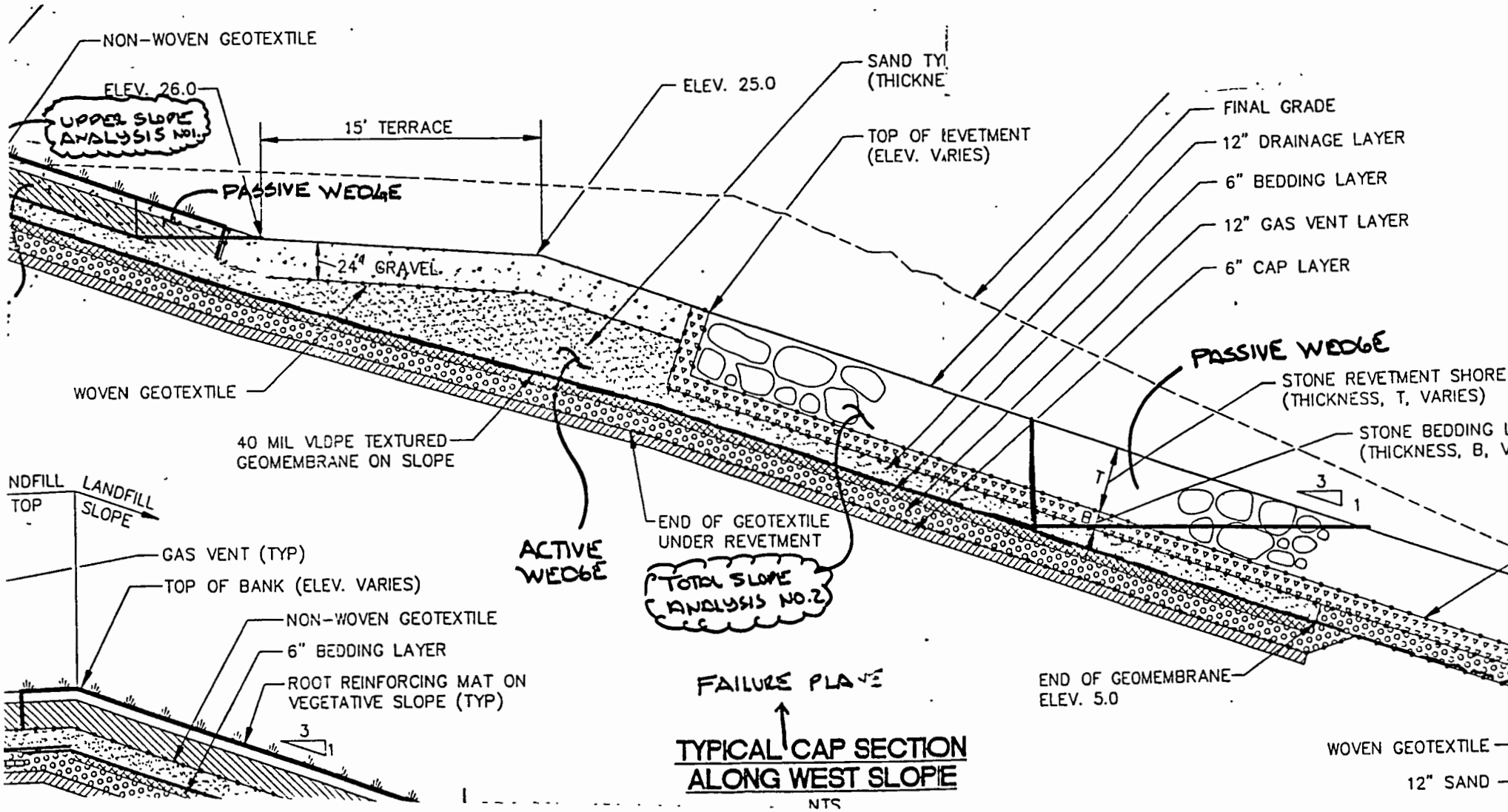


FIG. 3 SHEARING STRENGTH OF ROCKFILL FROM LARGE TRIAXIAL TESTS

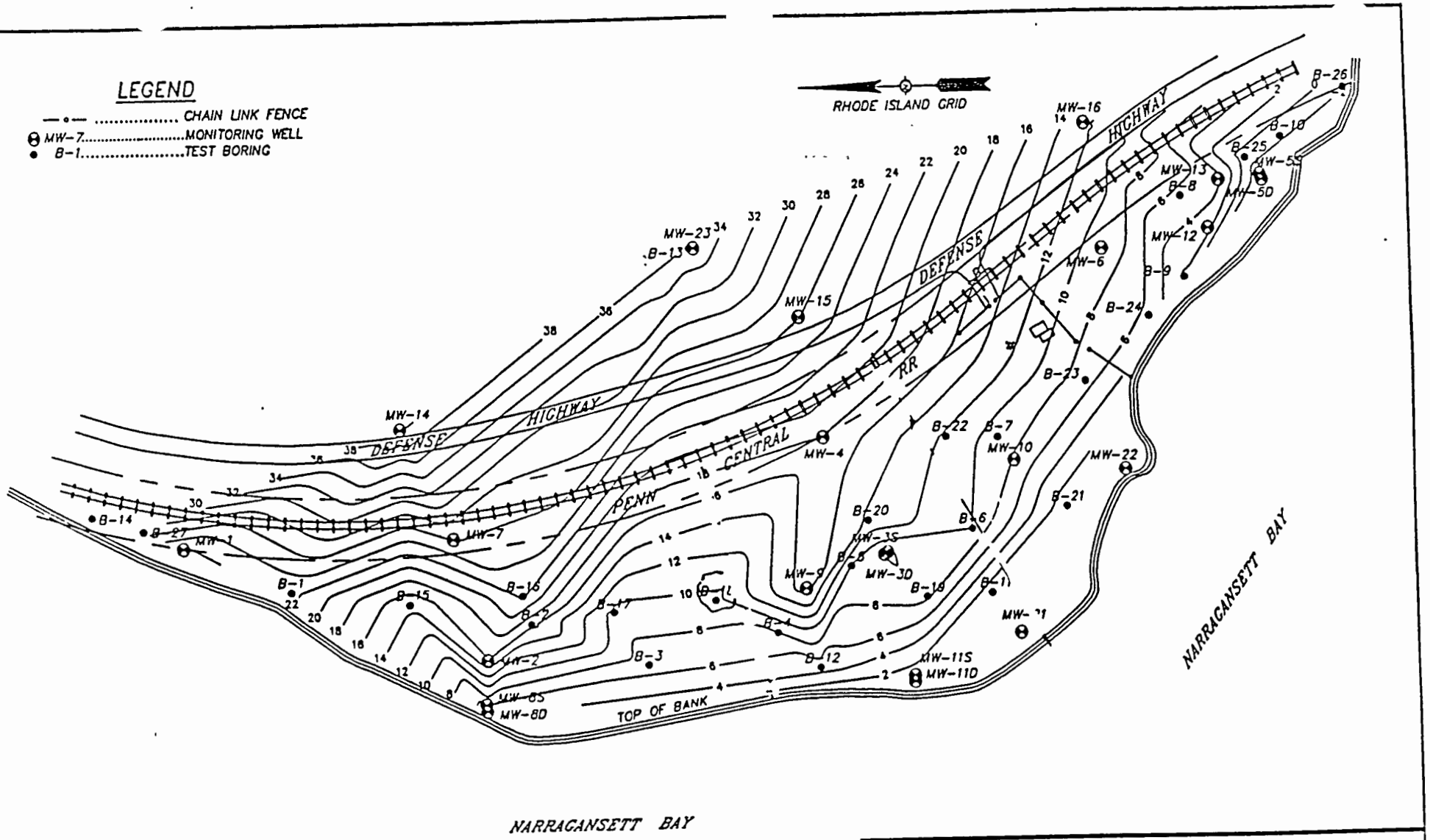
(Source: Thomas M. Leps, Trans. ASCE, 1972.)[2]

ATTACHMENT NO. 2



TYPICAL CAP SECTION
ALONG WEST SLOPE

NTS



GRAPHIC SCALE

200 0 100 200 400

(IN FEET)
1 inch = 200 ft.

TRC
TRC Environmental Corporation

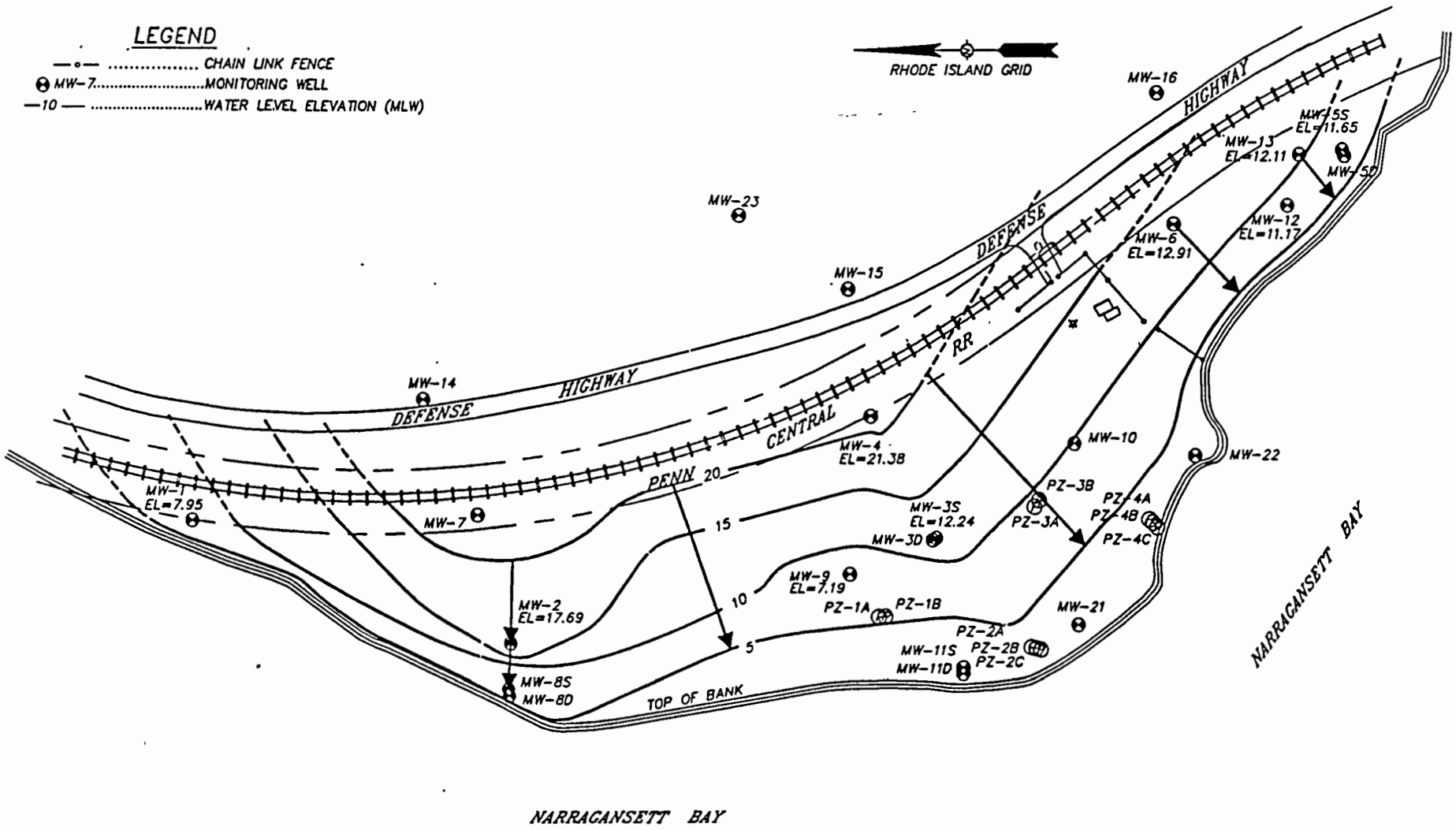
5 Waterside Crossing
Windsor, CT 06095
(203) 289-8631

NAVAL EDUCATION AND TRAINING CENTER — NEWPORT RHODE ISLAND

SITE 01 – McALLISTER POINT LANDFILL

FIGURE 3-9
BEDROCK CONTOUR MAP

Date: 2/94 | Drawing No.01043-0060-0040



GRAPHIC SCALE

200 0 100 200 400

(IN FEET)
1 inch = 200 ft.

TRC
TRC Environmental Corporation

5 Waterside Crossing
Windsor, CT 06095
(203) 289-8631

NAVAL EDUCATION AND TRAINING CENTER — NEWPORT RHODE ISLAND

SITE 01 – McALLISTER POINT LANDFILL

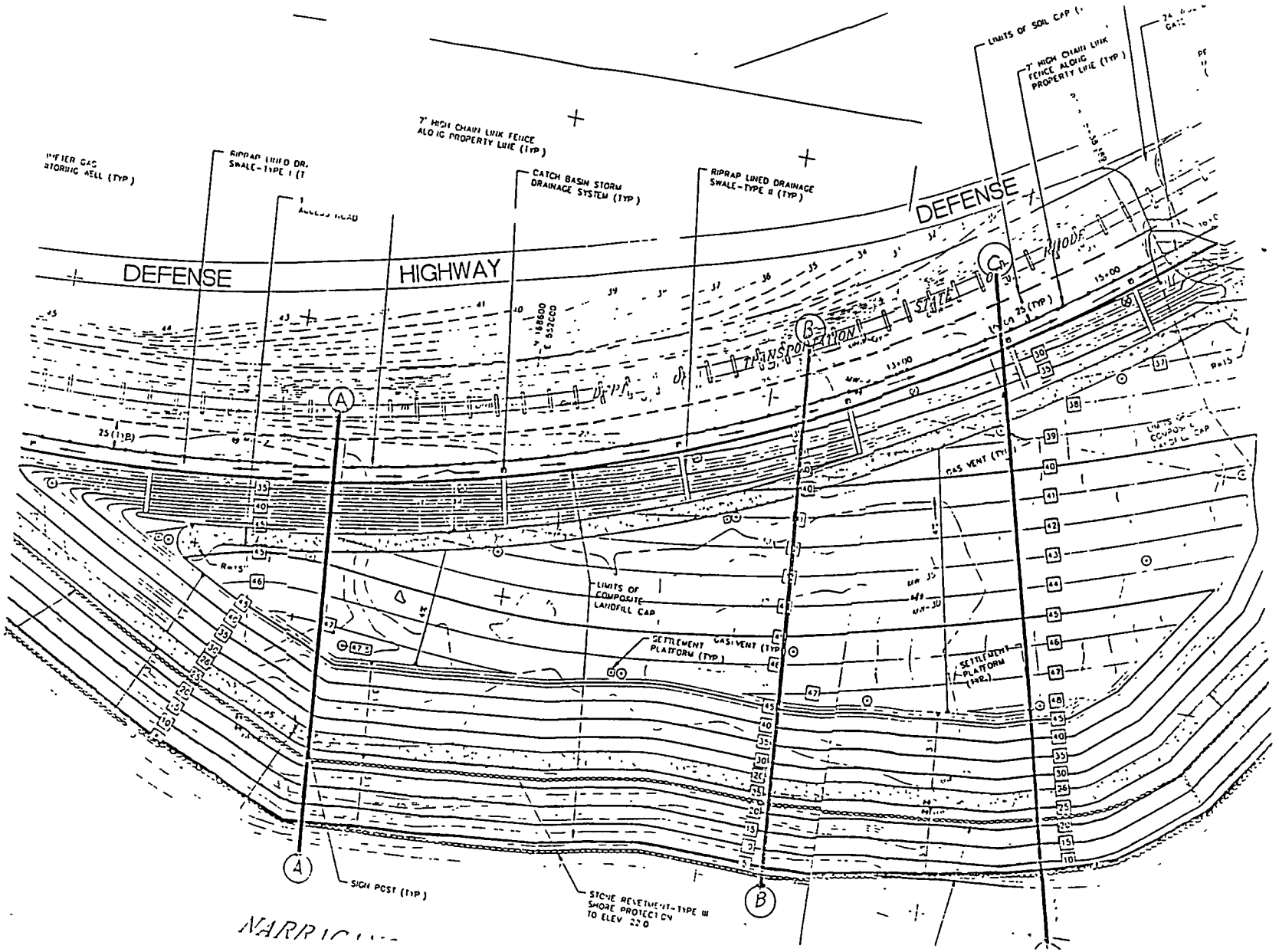
FIGURE 3-13
SHALLOW GROUND WATER CONTOUR MAP
(12/29/93)

Date: 2/94 | Drawing No. 01043-0060-0040

C:\10430060\FIG3-13M

APPENDIX B

CROSS SECTION I.D. PLAN
CROSS-SECTIONS



"STABL" PROGRAM

CROSS-SECTION LOCATIONS

APPENDIX C

COMPUTER PRINTOUTS

SECTION C-C SHALLOW FAILURE

** PCSTABL5 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	4-8-94
Time of Run:	5:20
Run By:	LM
Input Data Filename:	LF5B.PRN
Output Filename:	LF55.OUT

PROBLEM DESCRIPTION TRC-LANDFILL CAP MCALLISTER POINT LANDFILL

BOUNDARY COORDINATES

5 Top Boundaries
20 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	23.00	101.00	33.00	101.00	1
2	33.00	101.00	110.00	125.00	1
3	110.00	125.00	125.00	126.00	1
4	125.00	126.00	192.00	149.00	1
5	192.00	149.00	445.00	138.00	1
6	23.00	95.00	33.00	95.00	2
7	33.00	95.00	68.00	105.00	2
8	68.00	105.00	125.00	121.00	2
9	125.00	121.00	193.00	143.00	2
10	193.00	143.00	445.00	133.00	2
11	23.00	94.00	33.00	94.00	3
12	33.00	94.00	57.00	101.00	3
13	57.00	101.00	200.00	102.00	3
14	200.00	102.00	250.00	108.00	3
15	250.00	108.00	445.00	114.00	3
16	22.00	93.00	33.00	93.00	4
17	33.00	93.00	57.00	100.00	4
18	57.00	100.00	200.00	101.00	4
19	200.00	101.00	250.00	106.00	4
20	250.00	106.00	445.00	113.00	4

1

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	131.0	150.0	.0	31.0	.00	.0	1
2	100.0	121.0	200.0	23.0	.00	.0	1
3	120.0	130.0	.0	28.0	.00	.0	1
4	168.0	180.0	.0	35.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	45.00	105.00
2	175.00	105.00
3	290.00	111.00
4	445.00	117.00

Trial Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	127.78	126.95
2	137.49	124.58
3	147.46	123.78
4	157.43	124.58
5	167.14	126.95
6	176.36	130.84
7	184.84	136.14
8	192.37	142.72
9	197.38	148.77

Factor Of Safety For The Preceding Specified Surface = 1.985

Y A X I S F T

.00 55.63 111.25 166.88 222.50 278.13

```
                                  **
          -
          -                       **
          -                         W
     55.63 +                        *
          -                         *
          -
          -
          -
          -
A   111.25 +                           *
          -                           **
          -                            S
          -                           S
          -                           S
          -                           S
X   166.88 +                            S
          -                         W   S
          -                             S
          -                               **
          -                        *
          -
I   222.50 +
          -
          -
          -                         *
          -
          -
S   278.13 +
          -                          W
          -
          -
          -
          -
    333.75 +
          -
          -
          -
          -
          -
F   389.38 +
          -
          -
          -
          -
          -
T   445.00 +                         *W  **
```

Section C C Deep Failure

** PCSTABL5 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	4-8-94
Time of Run:	5:43
Run By:	LM
Input Data Filename:	LF5C.PRN
Output Filename:	LF56.OUT

PROBLEM DESCRIPTION TRC-LANDFILL CAP MCALLISTER POINT LANDFI
LL

BOUNDARY COORDINATES

5 Top Boundaries
20 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	23.00	101.00	33.00	101.00	1
2	33.00	101.00	110.00	125.00	1
3	110.00	125.00	125.00	126.00	1
4	125.00	126.00	192.00	149.00	1
5	192.00	149.00	445.00	138.00	1
6	23.00	95.00	33.00	95.00	2
7	33.00	95.00	68.00	105.00	2
8	68.00	105.00	125.00	121.00	2
9	125.00	121.00	193.00	143.00	2
10	193.00	143.00	445.00	133.00	2
11	23.00	94.00	33.00	94.00	3
12	33.00	94.00	57.00	101.00	3
13	57.00	101.00	200.00	102.00	3
14	200.00	102.00	250.00	108.00	3
15	250.00	108.00	445.00	114.00	3
16	22.00	93.00	33.00	93.00	4
17	33.00	93.00	57.00	100.00	4
18	57.00	100.00	200.00	101.00	4
19	200.00	101.00	250.00	106.00	4
20	250.00	106.00	445.00	113.00	4

1

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	131.0	150.0	.0	31.0	.00	.0	1
2	100.0	121.0	200.0	23.0	.00	.0	1
3	120.0	130.0	.0	28.0	.00	.0	1
4	168.0	180.0	.0	35.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	45.00	105.00
2	175.00	105.00
3	290.00	111.00
4	445.00	117.00

Trial Failure Surface Specified By 18 Coordinate Points

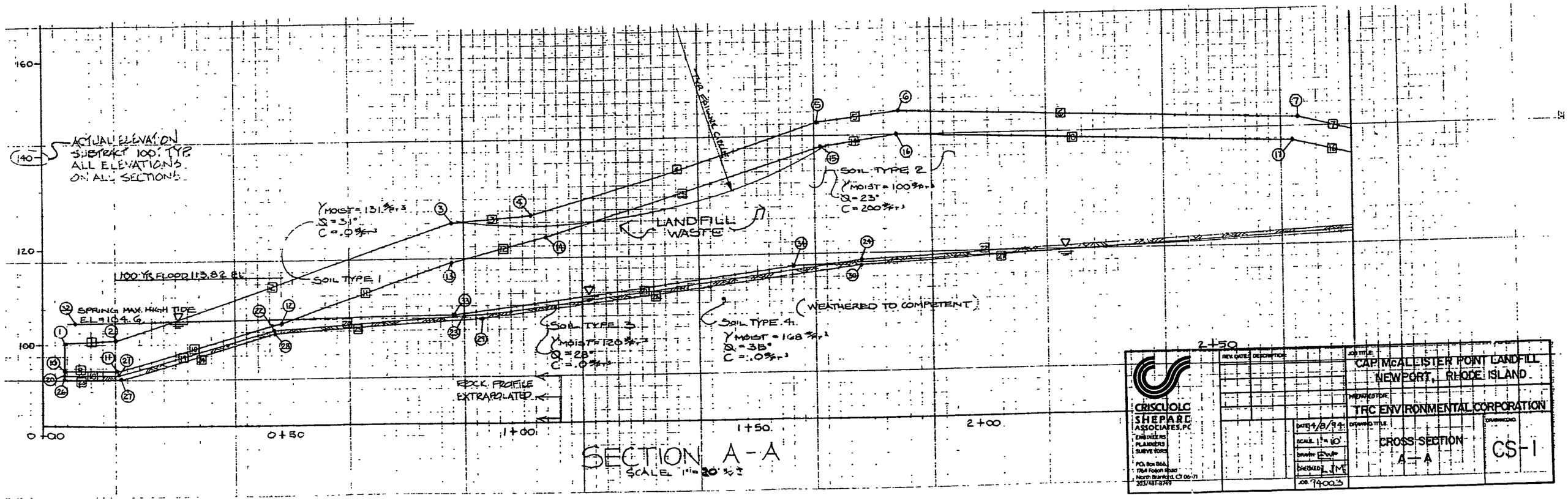
Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.00	106.30
2	59.79	104.27
3	69.69	102.85
4	79.66	102.03
5	89.66	101.84
6	99.65	102.26
7	109.59	103.29
8	119.46	104.93
9	129.20	107.18
10	138.79	110.02
11	148.18	113.45
12	157.35	117.44
13	166.25	122.00
14	174.86	127.09
15	183.14	132.70
16	191.05	138.82
17	198.57	145.40
18	201.78	148.57

FACTOR OF SAFTY FOR PRECEDING SPECIFIED SURFACE = 1.993

```
          Y          A    X    I    S          F    T

          .00     55.63   111.25   166.88   222.50   278.13

X       .00 +---------+---------+---------+---------+---------+
            -
            -              **
            -
            -              **
            -                S
      55.63 +               *S
            -                *
            -               S
            -               S
            -               S
            -               S
A    111.25 +                S  *
            -                S  **
            -                S
            -                 S
            -                 S
            -                  S
X    166.88 +                   S
            -                W   S
            -                     S
            -                      S**
            -               *       S
            -
I    222.50 +
            -
            -
            -                *
            -
            -
S    278.13 +
            -                 W
            -
            -
            -
            -
     333.75 +
            -
            -
            -
            -
            -
F    389.38 +
            -
            -
            -
            -
            -
T    445.00 +                 *W  **
```



SECTION A-A
SCALE 1"=20' H/V

CRISCUOLO SHEPARD ASSOCIATES, PC
ENGINEERS
PLANNERS
SURVEYORS
P.O. Box 866
1764 Foxon Road
North Branford, CT 06471
203/481-8749

REV. DATE	DESCRIPTION

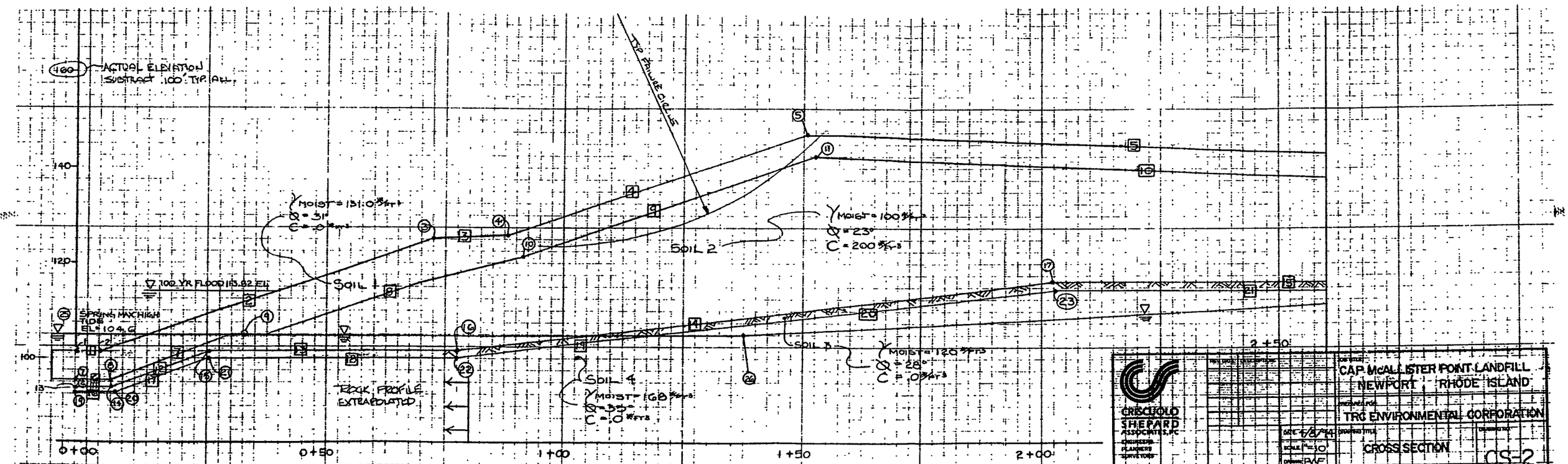
JOB TITLE: CAP McALLISTER POINT LANDFILL NEWPORT, RHODE ISLAND

PREPARED FOR: TRC ENVIRONMENTAL CORPORATION

DATE: 4/8/94
SCALE: 1"=10'
DRAWN: EWP
CHECKED: LJM
JOB: 94003

DRAWING TITLE: CROSS SECTION A—A

DRAWING NO.: CS-1



SECTION B-B

SCALE 1"=20' H & V

CRISCUOLO SHEPARD ASSOCIATES, PC
ENGINEERS PLANNERS SURVEYORS
P.O. Box 844
1764 Foxon Road
North Branford, CT 06471
203/481-8749

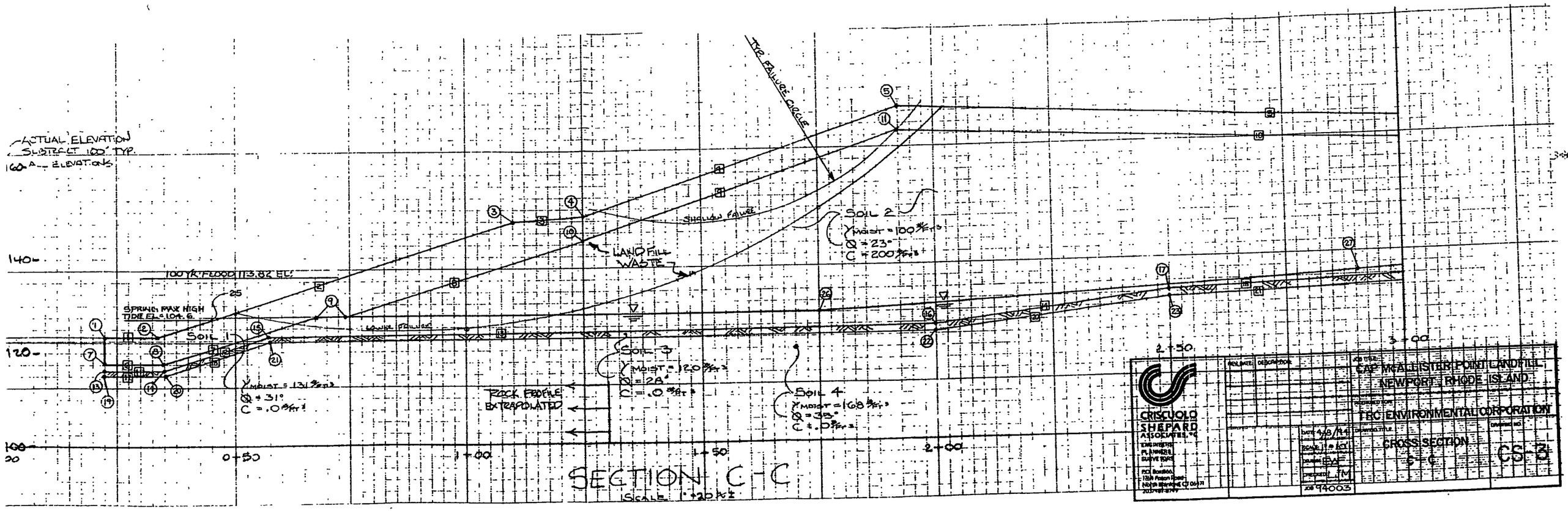
CAP McALLISTER POINT LANDFILL
NEWPORT, RHODE ISLAND

PREPARED FOR
TRC ENVIRONMENTAL CORPORATION

DATE 6/8/94
SCALE 1"=10'
DRAWN RMF
CHECKED LJM
JOB: 94003

CROSS SECTION
B — B

CS-2



NO. 1289—PROFILE PLATE A
"CLEARPRINT PAPER CO"
MADE IN U.S.A.